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Number 4

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Mariners Weather Log

National Oceanic and Atmospheric Administration • National Environmental Satellite, Data, and Information Service • National Oceanographic Data Center

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Mariners Weather Log

Editor: Elwyn E. Wilson

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Front Cover: Bull's-eye view of supertyphoon Vanessa at 2233, October 25 at near maximum intensity of 155 kn with a minimum sea-level pressure of 879 mb measured at 1114, October 26. This was only 9 mb higher and 10 kn slower than the record holder, supertyphoon Tip of 1979.

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The Secretary of Commerce has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this periodical has been approved by the Director of the Office of Management and Budget through April 1, 1986.

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Mariners Weather Log

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GENESIS OF ATLANTIC LOWS EXPERIMENT-- GALE

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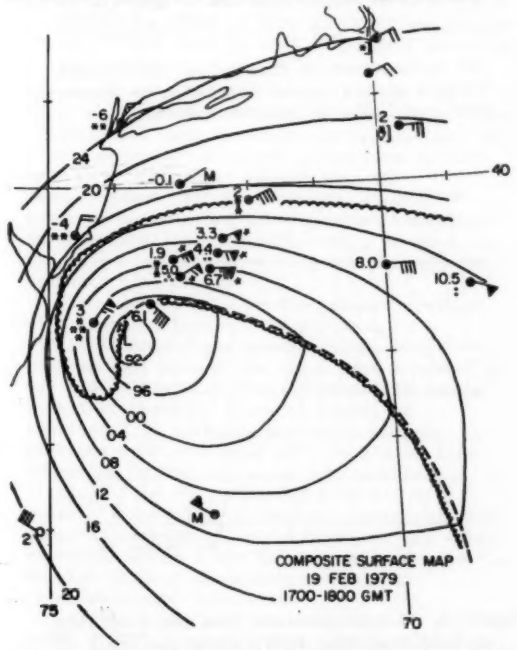
RESEARCH PROJECT HOPES TO LEAD TO FEWER FUTURE CALLS OF S.O.S.

WINTER EAST COAST STORMS

The mere mention of the term "noreaster" is enough to bring back memories to most seamen. Over the years these storms have caused considerable destruction both inland and over the waters offshore of the Atlantic Coast. In years gone by, as the intensifying low-pressure system moved northward from its origin off the Carolinas, the northeasterly winds in advance of the cyclone center often made widows and orphans of many of the families of the New England fishermen. Many a modern-day vessel has sustained damage or was sunk from these storms. In 1983, for example, the storms caused $1.5 billion in property damage and took at least 15 lives.

There are many examples of these storms, as several usually develop each year. A notable one was the "Presidents Day Snowstorm" of 18-19 February 1979 (fig. 1), which not only gave a crippling snow to Washington D.C., but also caused winds of at least 75 kn (38 m/s) over water. A less wintery but unusually intense cyclone was the "Queen Elizabeth II Storm" of 9-10 September 1978 (fig. 2), which was of hurricane intensity, with measured winds in excess of 65 kn (33 m/s). The QUEEN ELIZABETH II oceanliner was battered, and the dragger CAPTAIN COSMO was lost. The pressure trace from the freighter EUROLINER is shown in figure 3. Each of these storms had a tighter core than most mid-latitude cyclones, and had certain traits somewhat similar to tropical storms.

From a meteorologist's viewpoint, these coastal storms are particularly frustrating



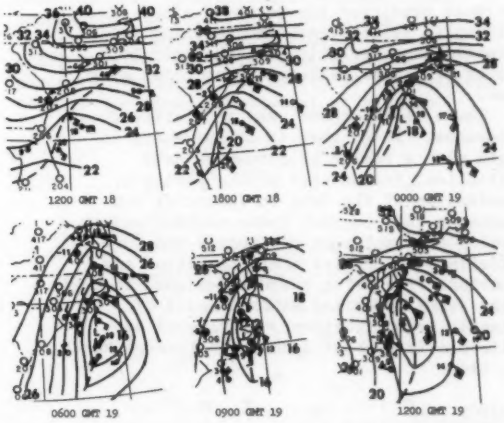


Figure 1. Surface weather maps of various stages of the Presidents' Day storm of 18-19 February 1979. Plotting is conventional except for temperatures in °C and winds in m/s (full barb = 5 m/s). Open station circles indicate buoys at which present weather is not reported. Adpted from Bosart (1981).

(a) Composite sectional map for 1700-1800 19 February 1979. Scalloping indicates convective region. Stars indicate post-storm-reported ship observations essential for researching the storm.

(b) Sectional plots illustrating coastal front (dashed) locations at indicated times on 18-19 February 1979, and selected observations of winds, air temperature, and clouds.

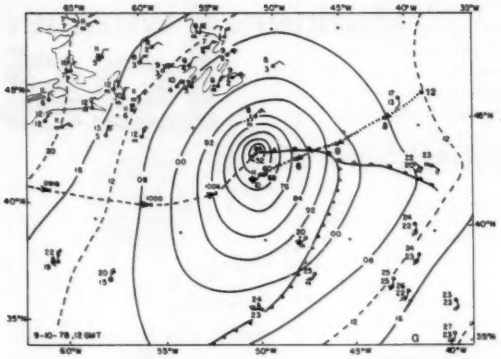
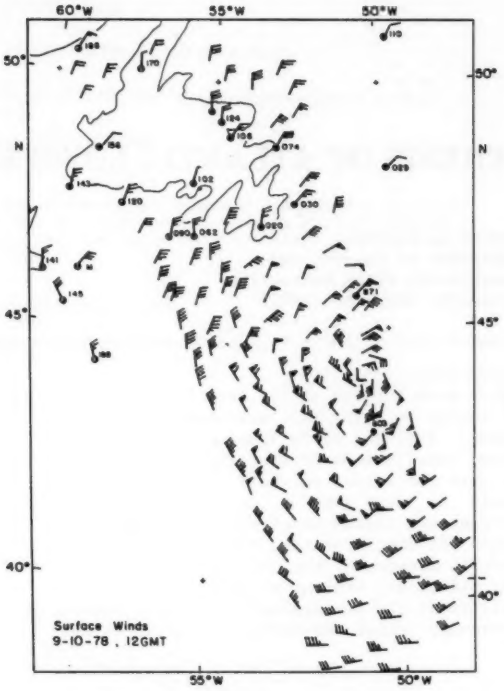


Figure 2. Surface observations from QUEEN ELIZABETH II storm of 9-10 September 1978. From Gyakum (1983).
(a) Sectional chart showing selected ship and buoy reports for 1200, 10 September 1978, isobars, and the paths and 6-hourly positions of the cyclone center and the EUROLINER.



(b) Winds observed from ships, land-based weather stations, and derived from Seasat data for 1200, 10 September 1978.

because they are so dangerous and yet so difficult to predict accurately. Even with the assistance of data from satellites and with supercomputers that run complex numerical models for predicting the weather, the forecasts for these storms are not consistently good. Neither the expert forecasters nor the sophisticated computer models can consistently predict when and where the storm will form, what direction and speed it will have, and how rapidly it will intensify. Experience with operational prediction models indicates that cyclones tend to be simulated better over the continent than over the oceans, with small, intense oceanic cyclones predicted the worst of all. Evidently, the processes controlling the formation and evolution of these offshore storms are quite different from those over land.

There is an urgent need to clarify these processes. To do that it is necessary to begin with a period of intensive data collection, follow that with a period of examination of the data to indentify the processes that control these storms, and then develop and implement new models and forecast guidelines to predict their formation and behavior. The first project designed to begin these tasks is called GALE--Genesis of Atlantic Lows Experiment. Data will be collected from about January 15 through March 15, 1986.

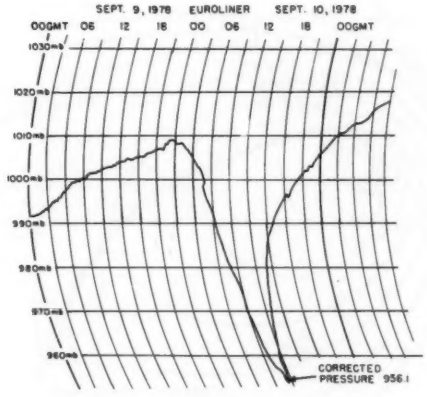


Figure 3. Barograph trace from the EUROLINER on 9-10 September 1978, along the track of figure 2b. From Gyakum (1983).

PROJECT GALE

Project GALE is a multi-agency, multi-University effort funded by the National Science Foundation (NSF), The Office of Naval Research (ONR), the National Aeronautics and Space Administration (NASA), the National Oceanic and Atmospheric Administration (NOAA), and others. Dr. Richard Dirks or NCAR is director of GALE, and Dr. John Bane of the University of North Carolina, Chapel Hill, is coordinating the physical oceanographic component of the project. Scientists from the National Center for Atmospheric Research (NCAR), the National Weather Service (NWS), NOAA, ONR, NASA, and from North Carolina State University, State University of New York at Albany, Pennsylvania State University,

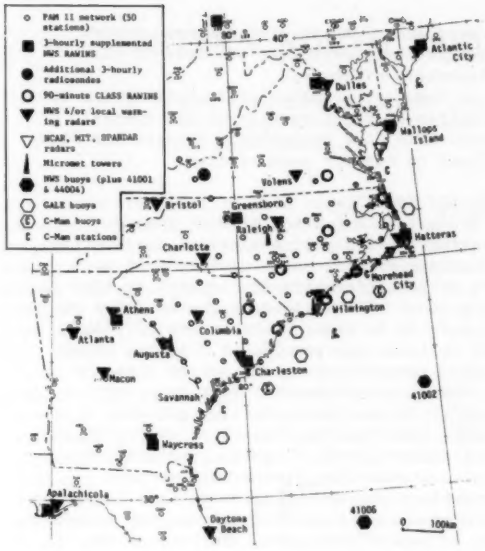


Figure 4. Surface and upper-air observation facilities in the core region of GALE. In addition, eight or more aircraft and one or more ships will be used to augment the data collection.

University of Washington, and a number of other universities will be participating. The project will have headquarters in Raleigh, NC, with a secondary aircraft operations center near Cape Hatteras. Also during the January-March 1986 period, the Canadian governmental weather service--the Atmospheric Environmental Service (AES)--will be studying the storms as they move into and through the Canadian offshore waters.

The project will be the largest of its kind ever undertaken. In addition to obtaining hourly and special surface observations around the clock from a number of NWS and military weather stations, including some that normally close at night, an additional 50 portable automatic weather stations (PAM stations) will be placed into operation in the Carolinas and southern Virginia (fig. 4). The PAM stations will measure temperature, pressure, humidity, wind speed and direction, precipitation, and other variables every 5 min and transmit them to the Raleigh project headquarters via GOES (geostationary) satellite.

At the ocean surface, measurements will be taken from 8 specially-deployed instrumented buoys moored between the shorelines of North and South Carolina and Georgia and the western edge of the Gulf Stream about 15-40 mi (30-80 km) offshore (fig. 4). Six of these have been developed specially for GALE and two are experimental buoys developed by NOAA. One or more research vessels and Navy ships will also collect data in this region.

To obtain adequate upper-air weather data in these rapidly-evolving storms, weather balloons bearing radiosonde instrument packages will be released at 3-hr intervals during about six 24-48 hour intensive operating periods that begin when conditions appear to be ripe for the formation of the coastal storms and continue until they move beyond Virginia. In addition, approximately 9 special upper-air stations will be put into temporary operation at the sites shown in figure 4. They will take observations at 3-hr intervals and occasionally even 90-min intervals. Most of these will be advanced sounding systems called CLASS (Cross-Chain LORAN Atmospheric Sounding Systems) that will determine balloon location (and, hence, winds) by tracking them using the LORAN system familiar to mariners. Routine NWS radiosonde wind direction and speed observations are computed from changes in balloon azimuth and elevation angles measured from a single antenna at the launch site, so the Loran triangulation method results in greater accuracy. Eight or more research aircraft will be making measurements both onshore and offshore at elevations from as low as 100 ft (30 m) over water to about 45,000 ft (13.5 km). In addition to having instrumentation onboard, several of these will drop instrument packages called dropsondes to increase the upper-air measurements in the over-water regions (fig. 5). The research and Navy ships will also release radiosonde-bearing weather balloons.

To study the details of the structure of the evolving storms, several Doppler radars will be installed in the vicinity of Cape Hatteras, enabling the detection of precipitation and its movement. The Doppler radar is like "conventional" weather radar except that in addition to measuring the intensity of the signal reflected back from precipitation, the radar also measures the change of frequency of the signal and relates that to the speed of movement of the air

Figure 5. Approximate dropwindsonde locations for a 12-hr period when a storm is forming along the Carolina coasts.

carrying the precipitation particles toward or away from the radar. By scanning a region with multiple radars it is possible to detect wind fields in three dimensions. These radars will be especially useful for determining if the thunderstorm or showery clouds and near-coastal fronts that are often present in these storms play a crucial role in subsequent intensification.

POSSIBLE REASONS FOR NEAR-COASTAL CYCLOGENESIS

The surface data, ship reports, buoy data, and aircraft data will be used to study the structure and evolution of the "coastal front" that forms near shore or just offshore (see the dashed lines on figure 1b). This coastal front separates cold air, having had origin over land to the north, from warmer air coming from the east with long fetch over water. The cyclone typically originates on and travels along this front. The coastal front is usually strong when a wedge-shaped ridge of high pressure and cold air is trapped along the east slopes of the Appalachian Mountains.

The warm water of the Gulf Stream, with the western edge about 45 mi (85 km) offshore, provides an immediate source of energy for storm formation by heating cooler air that flows over it. The warm water also provides a delayed source of energy because of water vapor supplied to the air via evaporation. Specifically, once the upward motions of the developing cyclone cause the water vapor to condense into clouds and precipitation, latent heat is given off and provides a source of energy for further development. Ship and buoy reports and low-level aircraft measurements are critical to the study of these processes.

The coastal storm appears to develop rapidly when the initial disturbance, which develops offshore along the coastal front in response to the above processes, is approached by an upper-air disturbance moving eastward from the Midwest. The network of upper-air soundings (which will extend to the Mississippi River on several occasions) and some aircraft flights will be used to detect the approach of these disturbances, and to determine their structure and role in the cyclogenesis offshore.

In summary, a number of factors appear to contribute to the formation of the coastal storms. The GALE measurement program has been designed to examine each of them.

A REQUEST FOR HELP

Project GALE intends to work toward improving the state of the art of forecasting, so that mariners can more routinely be made aware of possible storm development in time to take a route that will avoid the need for an "S.O.S." To do this, however, project GALE needs to issue its own "S.O.S." to the crews of ocean vessels during the period from mid-January to mid-March—"your data are needed". If you are travelling off the Atlantic Coast heading toward or away from the mid-Atlantic States, Virginia, the Carolinas, Georgia, or Florida, please take weather observations hourly. Please continue to take observations until in port and as soon as you begin to depart from port. Several of the crucial observations in figure 1 were not available in real time, but were essential for after-the-fact research on the storm. Just as the ocean can be your enemy once storms develop, it is project GALE's enemy because it makes data collection so difficult. Just as the EUROLINER's barogragh trace (fig. 4) was crucial for the study of that winter storm, and just as several ship reports were crucial for the analyses of figure 1, your weather observations could be critial evidence that enables project GALE to reach conclusions about the causes of these storms.

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Bosart, L.F., 1981: The Presidents' Day snowstorm of 18-19 February 1979: A subsynoptic-scale event. Mon. Wea. Rev., 109, 1542-1566.

Gyakum, J.R., 1983: On the evolution of the QE II storm: Synoptic aspects. Mon. Wea. Rev., 111, 1137-1155.

WE OF NOAA ARE MAKING USE OF THIS SMALL AMOUNT OF SPACE TO EXTEND OUR THANKS TO ALL THE SHIPS' OFFICERS WHO ROUTINELY TAKE SHIPBOARD WEATHER OBSERVATIONS. TO US, THESE EXCELLENT OBSERVATIONS ARE PRICELESS. WE CERTAINLY APPRECIATE RECEIVING THEM REGULARLY.

WESTERN NORTH PACIFIC TYPHOONS, 1984

Extracted from the annual Tropical Cyclone Report, 1984, U.S. Naval Oceanographic Command Center, Joint Typhoon Warning Center, Guam, Mariana Islands.

The western North Pacific experienced the sixth consecutive year of below average tropical cyclone activity during 1984. Thirty tropical cyclones occurred one less than the annual average. Only 3 significant tropical cyclones failed to develop beyond the tropical depression (TD) stage and 11 tropical storms (TS) failed to reach typhoon intensity. Of the 16 tropical cyclones that developed to typhoon (TY) intensity, 2 reached the 130 kn intensity necessary to be classified as super typhoons (STY). In the western North Pacific, tropical cyclones reaching tropical storm intensity or greater are assigned names in alphabetical order from a list of alternating male/female names. Table 1 provides a summary of key statistics for all western North Pacific tropical cyclones this year. Each tropical cyclone's maximum surface wind (in knots) and minimum sea level pressure (in millibars) were obtained from best estimates based on all available data. The distance traveled (in nautical miles) was calculated from the JTWC official best tracks.

Tables 2 through 4 provide further information on the monthly and yearly distribution of tropical cyclones and statistics on alerts and warnings.

Figures 6 through 9 show the tracks of the individual cyclones from first detection until dissipation or becoming extratropical. In the tables the storms are credited to the month that the first warning was issued. Maximum winds are estimates of 1-min average sustained speeds.

Individual typhoons are described in the following narratives. Times are GMT unless otherwise indicated. Tropical storm summaries may be found in Hurricane alley of the appropriate issue of the MARINERS WEATHER LOG.

The warning position is the best estimate of the center of the surface circulation. A forecast track is developed based on the rationale of the previous warning, guidance from the most recent set of objective techniques, numerical prognoses, and possibly subjectively modified by other information and considerations, and climatology. For

Table 1.--Tropical cyclone statistics, western North Pacific, 1984

TROPICAL CYCLONE			PERIOD OF WARNING	CALENDAR DAYS OF WARNING	NUMBER OF WARNINGS ISSUED	MAXIMUM SURFACE WINDS (KT)	ESTIMATED MSLP (MB)	BEST TRACK DISTANCE TRAVELED (NM)
01W	TS	VERNON	09 JUN - 11 JUN	3	9	40	993	556
02W	TS	WYNNE	19 JUN - 26 JUN	8	28	60	980	1609
03W	TY	ALEX	01 JUL - 05 JUL	5	18	75	970	1320
04W	TS	BETTY	06 JUL - 09 JUL	4	12	55	983	1157
05W	TY	CARY	07 JUL - 14 JUL	8	30	90	955	1355
06W	TY	DINAH	24 JUL - 01 AUG	9	35	125	915	2826
07W	TY	ED	25 JUL - 01 AUG	8	28	100	947	1700
08W	TS	FREDA	05 AUG - 08 AUG	4	12	55	982	1894
09W	TD	09W	11 AUG - 15 AUG	5	10	30	996	1328
10W	TS	GERALD	16 AUG - 21 AUG	6	24	55	979	1009
11W	TY	HOLLY	16 AUG - 22 AUG	7	25	75	963	1712
12W	TD	12W	24 AUG - 25 AUG	2	5	20	995	605
13W	TY	IKE	27 AUG - 06 SEP	11	42	125	947	2806
14W	TS	JUNE	28 AUG - 30 AUG	3	11	60	983	738
15W	TY	KELLY	13 SEP - 18 SEP	6	18	75	965	1297
16W	TS	LYNN	24 SEP - 27 SEP	4	14	40	996	553
17W	TS	MAURY	28 SEP - 01 OCT	4	13	60	992	863
18W	TS	NINA	28 SEP - 01 OCT	4	15	55	990	1201
19W	TY	OGDEN	07 OCT - 10 OCT	4	12	70	982	1236
20W	TY	PHYLLIS	11 OCT - 14 OCT	4	13	80	974	972
21W	TS	ROY	11 OCT - 13 OCT	3	9	35	996	735
22W	TS	SUSAN	11 OCT - 12 OCT	2	5	40	992	576
23W	TD	23W	17 OCT - 18 OCT	2	4	25	998	287
24W	TY	THAD	19 OCT - 24 OCT	6	21	120	925	2362
25W	STY	VANESSA	22 OCT - 31 OCT	10	31	155	879	3125
26W	TY	WARREN	23 OCT - 31 OCT	9	31	65	976	1111
27W	TY	AGNES	01 NOV - 08 NOV	8	28	120	925	2666
28W	STY	BILL	08 NOV - 22 NOV	15	52	130	909	2892
29W	TY	CLARA	14 NOV - 21 NOV	8	30	110	938	2709
30W	TY	DOYLE	04 DEC - 11 DEC	8	26	125	935	1960
			1984 TOTALS :	130*	611			

* OVERLAPPING DAYS INCLUDED ONLY ONCE IN SUM.

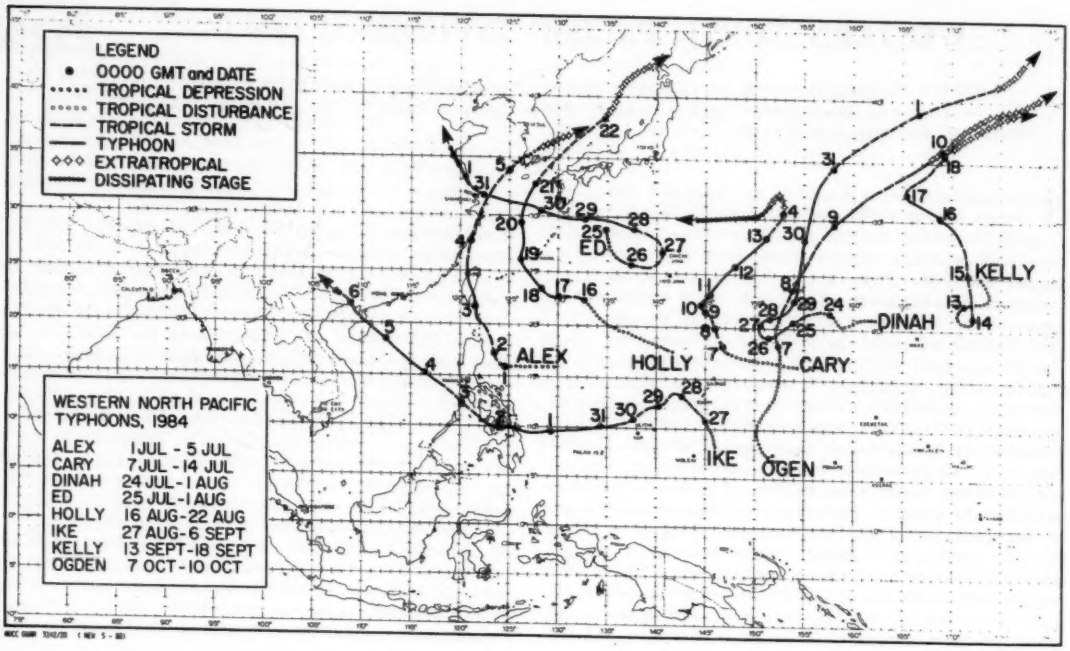


Figure 6.-- Typhoon tracks, 1984.

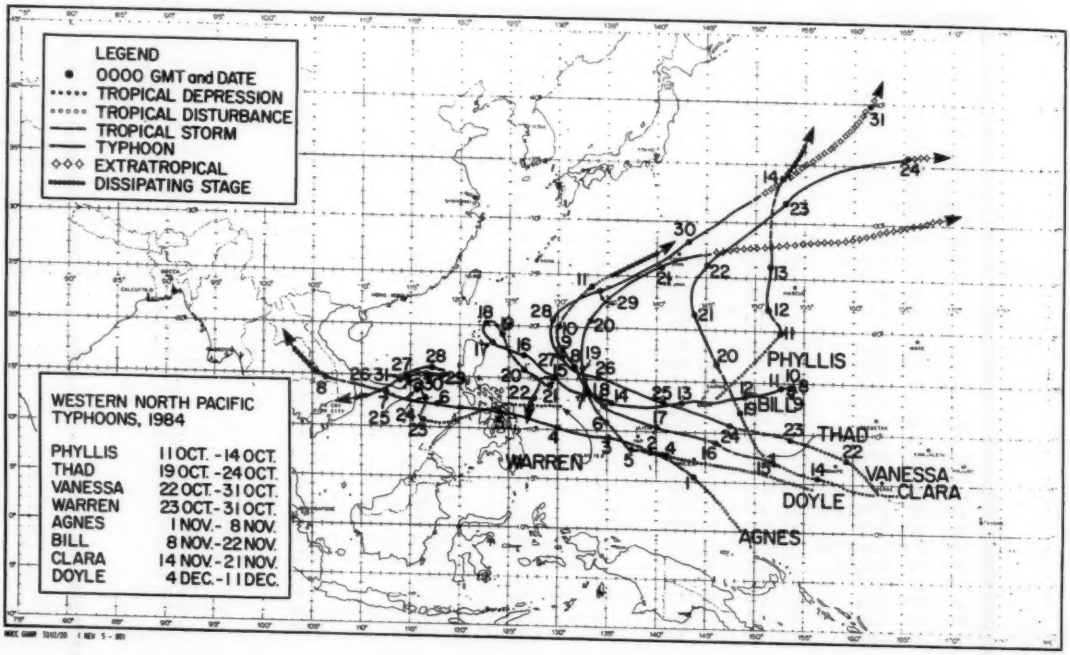


Figure 7.-- Typhoon tracks, 1984.

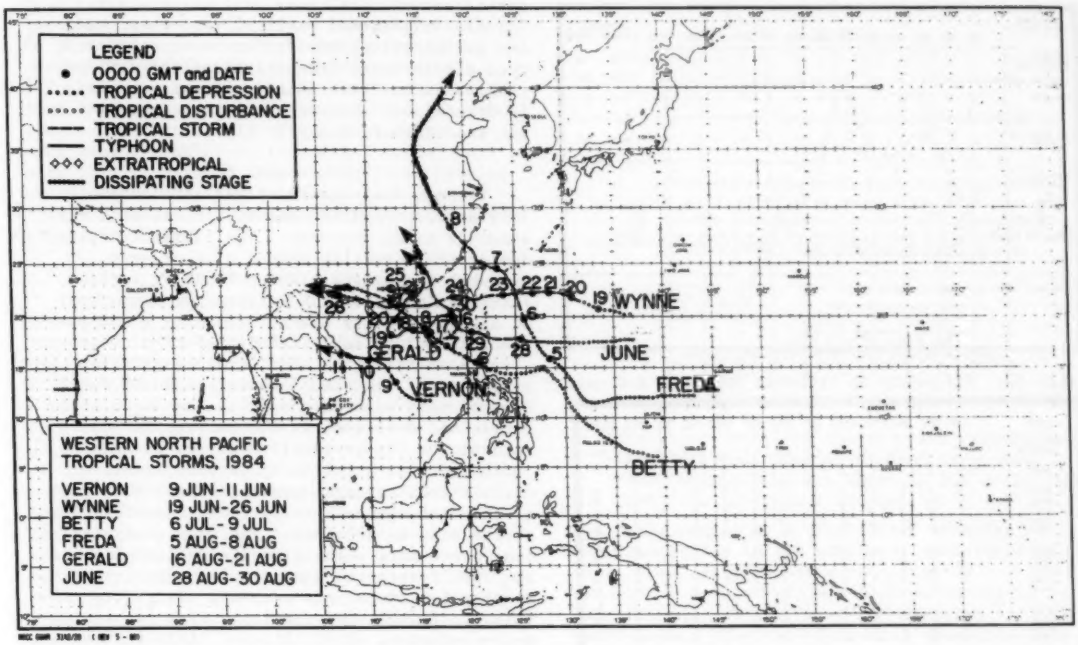


Figure 8.-- Tropical storm tracks, 1984.

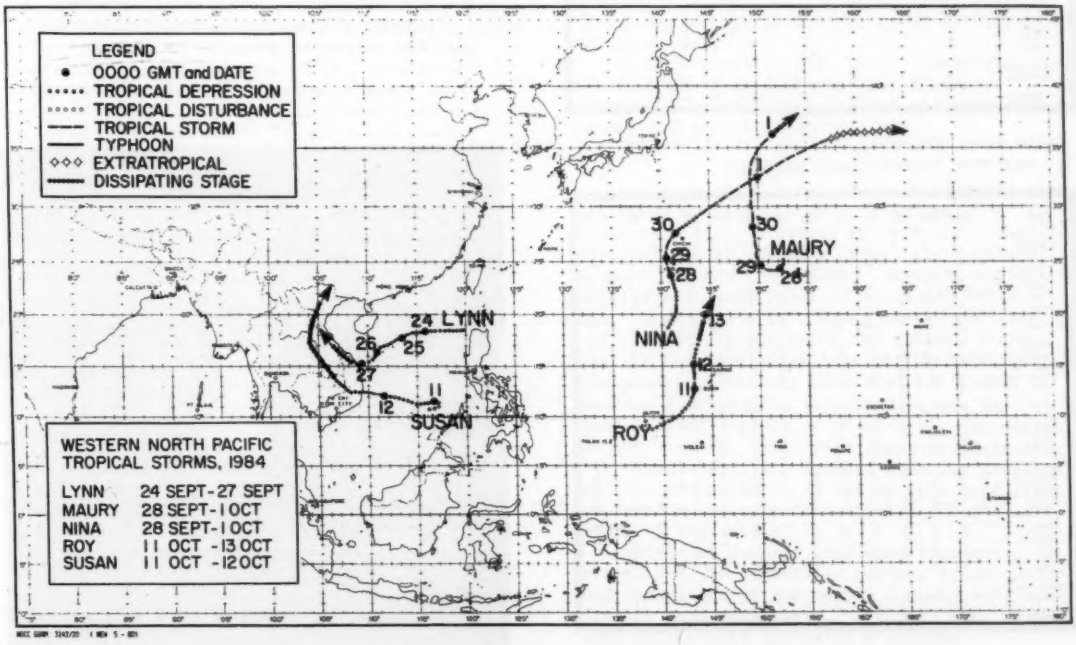


Figure 9.-- Tropical storm tracks, 1984.

Table 2.-- 1984 tropical cyclone statistics

WESTERN NORTH PACIFIC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL	(1959-1984) AVERAGE	CASES
TROPICAL DEPRESSIONS	0	0	0	0	0	0	0	2	0	1	0	0	3	3.8	98
TROPICAL STORMS	0	0	0	0	0	2	1	3	3	2	0	0	11	10.0	259
TYPHOONS	0	0	0	0	0	0	4	2	1	5	3	1	16	17.3	451
ALL TROPICAL CYCLONES	0	0	0	0	0	2	5	7	4	8	3	1	30	31.1	808
1959-1984 AVERAGE	.5	.3	.7	.8	1.3	2.0	4.9	6.3	5.7	4.6	2.7	1.4	31.1		
CASES	13	8	18	22	33	51	127	163	149	119	70	36	808		

FORMATION ALERTS: 30 of 37 Formation Alerts developed into significant tropical cyclones. Tropical Cyclone Formation Alerts were issued for all significant tropical cyclones that developed in 1984.

WARNINGS:
Number of warning days: 130
Number of warning days with two tropical cyclones in region: 46
Number of warning days with three or more tropical cyclones in region: 4

Table 3.-- Frequency of typhoons by month and year

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
(1945-1958) AVERAGE	.4	.1	.3	.4	.7	1.1	2.0	2.9	3.2	2.4	2.0	.9	16.3
1959	0	0	0	1	0	0	1	5	3	3	2	2	17
1960	0	0	0	1	0	2	2	8	0	4	1	1	19
1961	0	0	1	0	2	1	3	7	5	3	1	1	24
1962	0	0	0	1	2	0	5	7	3	4	3	0	25
1963	0	0	0	1	1	2	3	3	3	4	0	2	19
1964	0	0	0	0	2	2	6	3	5	3	4	1	26
1965	1	0	0	1	2	2	4	3	5	2	1	0	21
1966	0	0	0	1	2	1	3	6	4	2	0	1	20
1967	0	0	1	1	0	1	3	4	6	3	1	0	20
1968	0	0	0	1	1	1	1	4	3	5	4	0	20
1969	1	0	0	1	0	0	2	3	2	3	1	0	13
1970	0	1	0	0	0	1	0	4	2	3	1	0	12
1971	0	0	0	3	1	2	6	3	5	3	1	0	24
1972	1	0	0	0	1	1	4	4	3	4	2	2	22
1973	0	0	0	0	0	0	4	2	2	4	0	0	12
1974	0	0	0	0	1	2	1	2	3	4	2	0	14
1975	1	0	0	0	0	0	1	3	4	3	2	0	15
1976	1	0	0	1	2	2	2	1	4	1	1	0	15
1977	0	0	0	0	0	0	3	0	2	3	2	1	11
1978	0	0	0	1	0	0	3	2	4	3	2	0	15
1979	1	1	1	1	0	0	2	2	3	2	1	1	14
1980	0	0	0	0	2	0	3	2	5	2	1	0	15
1981	0	0	1	0	0	2	2	2	4	1	2	2	16
1982	0	0	2	0	1	1	2	5	3	3	1	1	19
1983	0	0	0	0	0	0	0	3	2	1	4	2	12
1984	0	0	0	0	0	0	4	2	1	5	3	1	16
(1959-1984) AVERAGE	.2	.04	.2	.6	.8	.9	2.8	3.3	3.2	3.1	1.7	.6	17.3
CASES	6	1	6	15	20	23	73	85	82	81	43	16	451

Table 4.-- Frequency of tropical storms and typhoons by month and year.

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
(1945-1958) AVERAGE	.4	.1	.4	.5	.8	1.3	3.0	3.9	4.1	3.3	2.7	1.1	21.6
1959	0	1	1	1	0	0	3	6	6	4	2	2	26
1960	0	0	0	1	1	3	3	10	3	4	1	1	27
1961	1	1	1	1	3	2	5	4	6	5	1	1	31
1962	0	1	0	1	2	0	6	7	3	5	3	2	30
1963	0	0	0	1	1	3	4	3	5	5	0	3	25
1964	0	0	0	0	2	2	7	9	7	6	6	1	40
1965	2	2	1	1	2	3	5	6	7	2	2	1	34
1966	0	0	0	1	2	1	5	8	7	3	2	1	30
1967	1	0	2	1	1	1	6	8	7	4	3	1	35
1968	0	0	0	1	1	1	3	8	3	6	4	0	27
1969	1	0	1	0	0	0	3	4	3	3	2	1	19
1970	0	1	0	0	0	2	2	6	4	5	4	0	24
1971	1	0	1	3	4	2	8	4	6	4	2	0	35
1972	1	0	0	0	1	3	6	5	4	5	2	3	30
1973	0	0	0	0	0	0	7	5	2	4	3	0	21
1974	1	0	1	1	1	4	4	5	5	4	4	2	32
1975	1	0	0	0	0	0	2	4	5	5	3	0	20
1976	1	1	0	2	2	2	4	4	5	1	1	2	25
1977	0	0	1	0	0	1	4	1	5	4	2	1	19
1978	1	0	0	1	0	3	4	7	5	4	3	0	28
1979	1	0	1	1	1	0	4	2	7	3	2	2	24
1980	0	0	0	1	4	1	4	2	6	4	1	1	24
1981	0	0	1	2	0	2	5	7	4	2	3	2	28
1982	0	0	3	0	1	3	4	5	5	3	1	1	26
1983	0	0	0	0	0	0	1	3	5	2	5	2	23
1984	0	0	0	0	0	0	2	5	5	4	7	3	1	27
(1959-1984) AVERAGE	.5	.3	.5	.8	1.1	1.6	4.5	5.4	4.8	4.1	2.5	1.2	27.3
CASES	12	7	14	21	29	42	116	140	126	107	65	31	710

intensity, heavy reliance is placed on intensity trends from aircraft reconnaissance, wind and pressure data from ships and land stations in the vicinity, plus the Dvorak satellite empirical model and climatology. Terrain influences, vertical wind shear and the extratropical environment are considered. Once the forecast intensity has been derived, the horizontal distribution of surface winds is determined. Warnings are issued every 6 hr for the standard synoptic times.

TYPHOON ALEX (03W)

Typhoon Alex was the first typhoon of the 1984 western Pacific season. It was also the season's first recurver. The satellite fixes during the formative stages of Alex were somewhat misleading. After reaching typhoon intensity and crossing Taiwan, the last phase of Alex's life was characterized by a complex transition into an extratropical LOW.

The seedlings of Alex first caught the attention of the JTWC forecasters on 28 June. Several ship reports showed that a circulation center had developed in the Philippine Sea. Late on the 29th, visual satellite pictures indicated that a partially exposed low-level circulation had developed on the northern edge of the disturbance. An aircraft investigation of the area was requested and upon arrival at the invest point, the aircraft radioed back to the JTWC forecaster that a well-defined circulation center was present. Satellite fixes indicated that the depression was moving west-southwest. Limited radar fixes indicated that the system was nearly stationary. However, when the daylight satellite pictures became available late on 1 July, it was obvious that the system had in reality moved north-northwest and was now a tropical storm.

Once the northward movement of Alex was

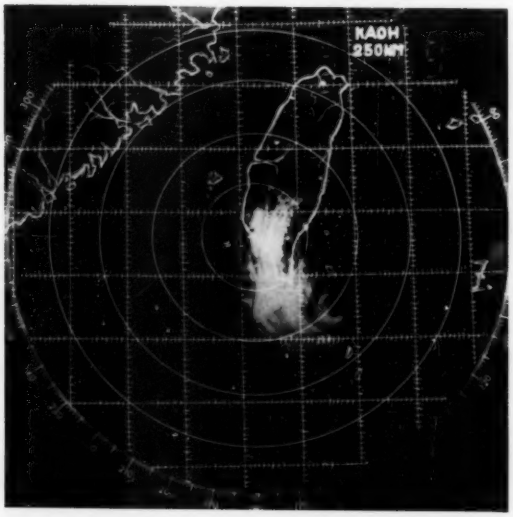


Figure 10.-- Radar scope photograph of Alex southeast of Taiwan. JTWC.

well established, the forecasts were relatively accurate. Alex continued to intensify reaching a maximum intensity of 75 kn just prior to crossing Taiwan (fig. 10). During the middle and last phases of Alex's life, the southwesterlies in front of a trough that laid over central Korea provided the steering mechanism. Starting on 5 July Alex underwent a complex extratropical transition with this trough and front. The final warning was issued at 05/1200 as Alex became indistinquishable from the frontal system over the Sea of Japan.

TYPHOON CARY (05W)

Typhoon Cary was the first storm of the season to be initiated by the Tropical Upper Tropospheric Trough (TUTT). While remaining over water its entire life, Cary distinquished itself by unusual intensity changes.

The disturbance which eventually developed into Typhoon Cary was first noticed on 2 July as an area of very poorly organized convection in the eastern, divergent side of a westward moving TUTT cell. Surface synoptic data indicated only easterly trades were present beneath the convection. Early on the 5th, the convection became more organized with satellite imagery indicating an anticyclone developing aloft over the system; however, due to sparse surface reports, the presence of a surface circulation could not be confirmed.

Aircraft reconnaissance late on the 6th, had no trouble locating a surface circulation and reported that the disturbance had an MLSP of 1004 mb with estimated maximum surface winds of 25 kn. Based on this report, the first warning on Cary was issued at 0000 on the 7th. During the next 12 hr, satellite imagery indicated the depression was slowly intensifying. This was confirmed by the next aircraft reconnaissance flight which found Cary had intensified to storm strength with a narrow band of 35 to 40 kn surface winds north of its center and an MSLP of 999 mb.

Cary continued to intensify as it moved to the northwest toward an apparent break in the subtropical ridge. Reconnaissance missions were flown on 8 and 9 July to better define the mid-level flow north of Cary. These flights confirmed the presence of a weakness in the ridge, which indicated that forecasts for slow northwestward movement with eventual recurvature to the northeast were sound. Cary slowed as it approached the weakness in the subtropical ridge while continuing to intensify. At 1200 on the 9th, Cary was upgraded to typhoon status based on aircraft and satellite data which indicated that a 30 mi wide eye had formed, 700 mb flight level winds were 64 kn, and an MSLP of 975 mb existed. During the subsequent 12 hr Cary intensified quite rapidly, reaching a maximum intensity of 90 kn with an MSLP of 955 mb at 09/2332. Figure 11 shows Cary just prior to reaching maximum intensity. Between 0000 on the 9th and 1200 on the 10th, Cary moved very slowly through the ridge axis. Recurvature to the northeast was underway by 10/1200. This

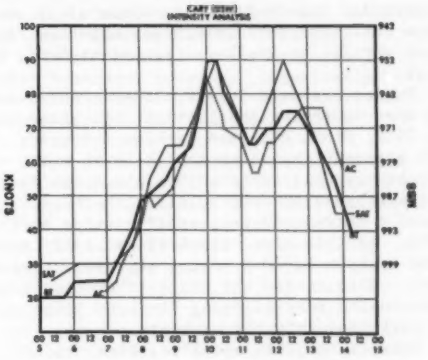


Figure 11.-- Satellite and aircraft reconnaissance intensity estimates of typhoon Cary. Best track intensities are shown as the solid line. From JTWC 1984 Annual Report.

was accompanied by a significant shearing of the convection in the northwest semicircle of the storm resulting in a reduction of intensity to near minimum typhoon strength. Approximately 18 hr later the shearing environment over Cary decreased resulting in a gradual increase in convection and a halt to the weakening trend. At 1118 on the 11th the ARWO reported that Cary was once again developing an eye; this time 40 mi across. This large eye persisted for 24 hr as Cary reintensified.

As Cary moved further north, increasing vertical shear and entrainment of cooler, drier air caused Cary to weaken and gradually become extratropical on the 14th.

TYPHOON DINAH (06W)

During much of July, the North Pacific was dominated by slow moving or stationary features. After tropical storm Betty dissipated over southern China, the southwest monsoon did not re-develop. Instead, surface ridging was established in the South China Sea. Gradually this ridging spread eastward, and by mid-July dominated the western North Pacific from Southeast Asia to the dateline. The anomalous ridging persisted for almost 2 weeks. Accompanying this ridging was an almost total absence of significant convection in the tropics. With high pressure dominating the climatologically favored area for tropical cyclone development, it was up to a cold front to provide the genesis mechanism for the next storm of the season.

Satellite imagery indicated that the trough and its associated surface front, which had been inactive for nearly a week, were finally moving eastward. Synoptic data at 1200 on the 21st indicated a surface circulation had formed beneath the convection, approximately 300 mi to the northwest of Wake Island. During the next two days, the

disturbance drifted slowly westward. The first aircraft reconnaissance of the disturbance located a 1000 mb circulation center, and observed surface winds of 30 kn. Since continued development was expected, the first warning on Dinah was issued at 0600, 24 July.

During the next 2 days, Dinah tracked to the west-southwest and intensified. Late on the 25th, Dinah attained typhoon intensity with aircraft reporting that a 30 mi wide circular eye had formed. Dinah's track to the west-southwest is attributed to the flow around a narrow mid-tropospheric ridge to the north. At this time, tropical storm Ed (soon to be typhoon Ed) was moving southeast towards Dinah. This caused the ridge to the north to slide to the east allowing Dinah to turn to the northwest into the weakness.

Between the 26th and 28th, Dinah and Ed were within 900 mi of each other, with the closest point of approach being at 26/2100 when they were approximately 630 mi apart(fig.12).

Figure 12.— Typhoon Dinah and tropical storm Ed near their closest point of approach at 2213, July 26. NOAA.

After intensifying for 3 days, Dinah weakened for a 12 to 24 hr period on the 27th. This weakening happened after the closest point of approach between the two storms had occurred. This interaction resulted in a significant shearing and suppression of the convection in the northwest quadrant of Dinah, a temporary weakening of the eye and eyewall and an increase in the central pressure. By early on the 28th, with the distances between Ed and Dinah increasing, the shearing decreased and Dinah intensified rapidly, reaching its maximum intensity of 125 kn at 0000 on the 29th.

By now Dinah was moving to the north-northeast and increasing its forward speed as the storm tracked along the westward edge of the mid-Pacific high. On the 29th Dinah made her closest point of approach to Marcus Island with an intensity of 115 kn. This was Dinah's only interaction with land and caused extensive damage to vegetation on the island. The Coast Guard Loran station sustained an estimated $30,000 worth of damage to various buildings and equipment. Maximum observed winds on the island were 63 kn with a peak gust to 89 kn.

After passing clear of Marcus Island, Dinah continued to move to the north-northeast. Early on the 31st Dinah was downgraded to a tropical storm. A mid-latitude trough which had already been interacting with Dinah for approximately 12 hrs, now started steering the storm towards the northeast. Transition to an extratropical LOW, which began at about 1200 on the 30th, was completed by 1200 on 1 August.

TYPHOON ED (07W)

Typhoon Ed, like its predecessor Typhoon Dinah, originated from a mid-latitude system. Forming just south of Japan, Ed initially moved to the southeast, a very unusual direction of movement for tropical cyclones in the northwest Pacific. After briefly interacting with Typhoon Dinah, Ed turned to the west-northwest, a course it maintained until it made landfall on the east coast of China.

The disturbance which eventually developed into Ed began as an area of convection at the southern end of a dissipating cold front transiting Japan. At 0000 on 25, July, synoptic data indicated a surface circulation had formed, with an MSLP near 1002 mb. Satellite imagery and synoptic data indicated an upper-level anticyclone had developed over the disturbance providing excellent outflow to the south. The area rapidly transitioned from an extratropical feature to a tropical depression as the convection increased and became more organized. On the 25th, synoptic data showed surface pressures had decreased to 999 mb and Dvorak satellite intensity analysis estimated surface winds of 30 kn. The first warning on Ed was issued at 1800 on the 25th.

While Ed was developing, Typhoon Dinah located approximately 900 mi to the southeast, was moving to the west and intensifying. Ed continued to intensify as he moved to the southeast. Aircraft reconnaissance late on the 25th found Ed had deepened to 985 mb and was supporting winds of 40 to 50 kn. Ed maintained a 50 kn intensity during the next 24 hr as he moved closer to Dinah. Throughout this period, Ed's outflow remained very well organized and was elongating to the east towards Dinah. This outflow had significant short term effect on Dinah's convection and intensity early on the 27th.

During the 26th, a short-wave trough moved eastward across the Sea of Japan. In response to the through, Ed turned to the north while maintaining his intensity. By the 27th, the trough had moved to the northeast and was weakening. Ed now came under the influence of a mid to low-level ridge east of Japan. This ridge kept building to the west and forced Ed to move to the west-northwest, a course it maintained until landfall.

While moving to the west Ed slowly intensified, reaching its peak intensity of

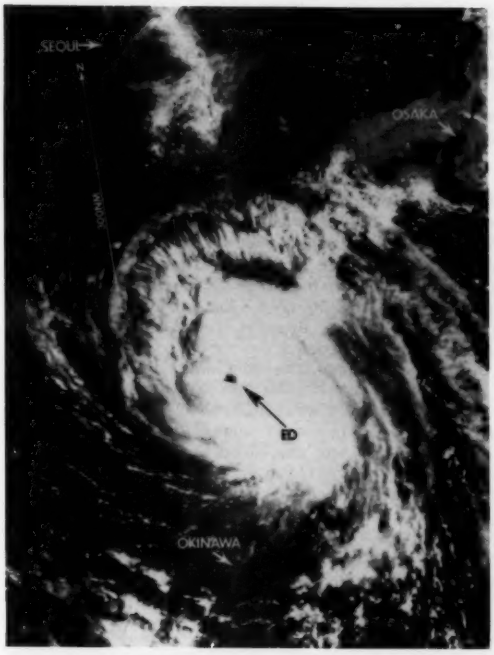


Figure 13.-- Typhoon Ed at maximum intensity of 100 kn. NOAA Imagery.

100 kn shortly after passing south of the island of Kyushu (fig. 13). As Ed transited the East China Sea, entrainment of drier air and passage over cooler waters began to weaken the system. At 0900 on the 31st, Ed made landfall approximately 60 mi north of Shang-Hai. Maximum sustained winds at landfall were 60 kn. After making landfall, Ed turned to the northwest, transited along coastal China and gradually dissipated.

The only known damage caused by Typhoon Ed occurred to shipping. The Korean registered ISHLIN GLORY enroute from Pohang, South Korea to Nagoya, Japan sank in the Korea Strait on 29 July. One crew member is known dead, with eleven others reported missing.

TYPHOON HOLLY (11W)

Typhoon Holly formed in the eastern extension of the monsoon trough at the same time that tropical storm Gerald was forming in the South China Sea. It was the fourth significant tropical cyclone to develop in the trough in less than 2 weeks. Holly was unusual in that it never was, by definition, a tropical depression. Because it evolved from a very active monsoon trough, Holly was already at tropical storm strength when it finally attained a closed circulation. Despite only reaching a maximum intensity of 75 kn, Holly significantly affected much of the western North Pacific due to its large wind field.

On the 13th the monsoon trough extended from the weakening tropical depression 09W eastward to just northwest of Guam. On the 14th the eastern end of the trough had moved northwest and become sharper. Synoptic data indicated the trough had deepened with an MSLP near 1000 mb. Numerous 20 to 35 kn ship reports existed south of the trough axis in the active southwest monsoon. Organization of the convection over the trough also improved during this period, and suggested that a surface circulation was forming.

The first aircraft reconnaissance mission into the disturbance on the 15th found only a sharp trough with 25 kn surface winds and an MSLP of 998 mb. At 1200 synoptic data indicated that the southwest monsoon along with a tight pressure gradient between the monsoon trough and the subtropical ridge to the northwest, were now generating gale force winds both north and south of the trough axis.

The second aircraft investigative mission into the disturbance closed-off a circulation center at 0225 on the 16th and found that the MSLP had decreased to 992 mb. Gale force winds were observed within of 2° of the center.

Determination of the initial intensities of Holly and its associated 30 kn wind radii were difficult since the gale force monsoon flow extended for hundreds of miles to the south and east of the storm. As Holly developed, it took the monsoon flow into its circulation and subsequently became a very large storm.

Figure 14 shows the wind field associated with Holly as reported by reconnaissance aircraft on 18 August. This flight was representative of the data obtained on many of the missions while Holly was a typhoon. The center was characterized by a large area of lighter winds. Generally throughout the life of Holly, the highest winds were found in a band 60 to 150 mi from the center. Within

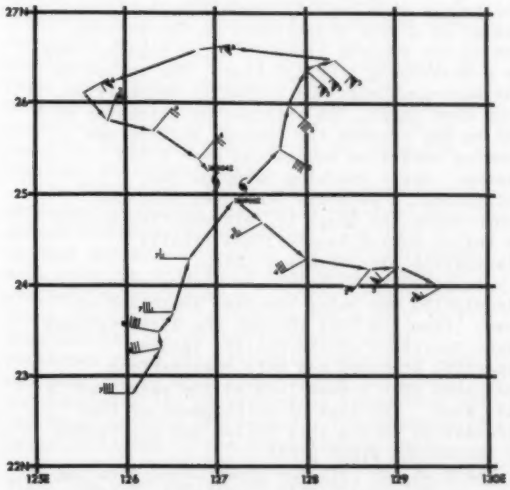


Figure 14.-- Plot of 700 mb winds measured by aircraft reconnaissance of Holly. The center was fixed at 0900 and 1134 on the 18th. From JTWC 1984 Annual Report.

this band, the strongest winds were usually observed in the northern and eastern portions of the storm. The winds observed at Kadena AB, Okinmawa confirmed the aircraft reports. The maximum sustained wind reported at Kadena was 50 kn at 19/1355 with a peak gust to 72. Fortunately, despite the strong winds and the 16.76 in of rain, there were no deaths or serious damage reported on Kadena AB. However, some 16,000 air and ferry travelers were stranded on the island during Holly's passage.

Holly initially moved to the west under the influence of the subtropical ridge, reaching typhoon intensity on the 18th. At that time Holly had turned to the northwest a course it maintained for almost 30 hr. After passing west of Okinawa, Holly turned to the north for the next 24 hr with no significant intensity changes. At this point the westerlies began to influence the storm and Holly was steered to the northeast and began to accelerate.

As Holly passed through the Korean Strait, it inflicted considerable damage on the Korean peninsula and the Japanese Island of Kyushu. News reports indicated at least one person killed, nine missing and eleven injured. Property damage was estimated initially at one million dollars. Heavy rainfall accompanied the storm. Miyazake on Kyushu recorded 15 in of rain during a 24 hr period. Extensive flooding and landslides were also reported.

Holly weakened as it transited the Korean Strait due to interaction with the rugged terrain. As Holly entered the Sea of Japan, it began transitioning to an extratropical system.

TYPHOON IKE (13W)

The deadliest typhoon to strike the Philppines this century began innocently enough as a weak disturbance on the eastern end of the monsoon trough. After passing Guam as a developing tropical storm, Ike turned to the west-southwest and gradually intensified. Four days later, Ike attained an intensity of 125 kn and crossed the central Philippines causing extensive damage and over 2,000 deaths. After wrecking havoc on the Philppines, a weakened Ike moved into the South China Sea where it reintensified to 115 kn before making landfall and finally dissipating over mainland China.

As early as 21 August, a weak surface circulation was being analyzed southeast of Guam. From the 21st through the 25th, various Trust Territory of the Pacific Islands reporting stations and ship observations indicated that a weak 1009 mb low persisted in this area. The lack of development of this circulation during this period was attributed to the strong winds aloft.

Late on the 25th the upper-level shearing began to decrease. This resulted in a rapid increase in the convection over the low-level circulation center. On the 26th the disturbance, which was to develop into Ike, began to show continuity. The first warning on Ike was issued at 0000 on the 27th. The initial forecast track called for Ike to move to the northwest. Guam was placed in Condition of Readiness III on the 27th. This was the first time since 1 December 1982 that Guam had been other than Condition of Readiness IV. (At that time Typhoon Pamela was approaching from the east.)

The first aircraft reconnaissance flight on the 27th into Ike fixed the center approximately 120 mi south of Guam with a MSLP of 997 mb and estimated the maximum surface winds at 35 kn. The storm remained compact as it passed 90 mi southwest of Guam, Ike supported winds of 50 to 60 kn but due to the compact circulation, Guam suffered no ill effects from the storm.

After passing to the southwest of Guam, Ike continued tracking to the northwest for the next 12 hr. On the 28th, Ike reached the northern most latitude it would attain in the Philippine Sea. For the next 4 days Ike would track towards the Philippines on a west-southwest course.

Late on the 28th shearing decreased slightly which allowed Ike to intensify to typhoon strength. Aircraft reconnaissance reported surface and flight level winds of 75 kn, yet the MSLP was only 991 mb. As Ike turned more to the west on the 30th, the upper-level anticyclone over Ike redevelped. At 30/02310 aircraft reconnaissance found the MSLP had decreased to 971 mb and reported 700 mb flight level winds of 65 kn. During this second intensification, Ike's circulation became larger - more typical of a WESTPAC typhoon.

For the next 2 days Ike tracked toward the central Philippines and doubled in intensity. Figure 15 shows Ike as it neared the Philippines. On the 1st of September just prior to hitting the Philippines, the last aircraft reconnaissance flight was made. The lowest MSLP found was 947 mb at 01/0845 and 700 mb flight level winds of 117 kn were measured in the eyewall of a 25 mi circular eye. The maximum surface window were

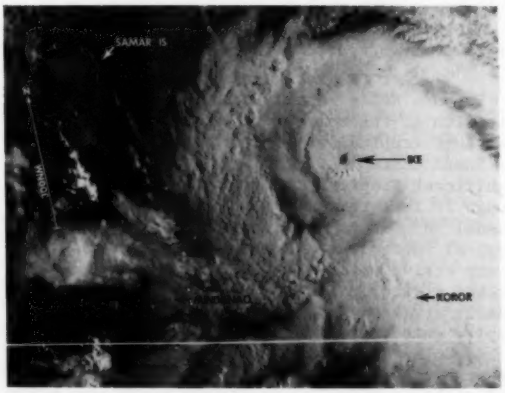


Figure 15.-- Typhoon Ike as he approached Leyte Gulf with winds of 105 kn at 2252 on August 31. NOAA Image.

estimated at 120 to 130 kn.

For the next 30 hours Ike cut a path of death and destruction across the central Philippine Islands that is unequaled in recent history. In the wake of its path, Ike left a reported 1,026 people dead, with 1,147 missing and presumed dead. Published figures for the number of people left homeless in the central Philippines range from 200,000 to 480,000. The worst hit region was the Surigao del Norte Province of Northern Mindanao where approximately 1000 people died (fig. 16).

Figure 16.-- Aerial reconnaissance of a town in Mindanao showing damage from Ike. Photo by CDR M. McCallister, Naval Oceanography Command Facility, Cubi Point.

Ike tracked to the west-northwest and then to the northwest as it crossed the Philippines and weakened. At 0000 on 3 September Ike had weakened to 45 kn. Ike quickly reintensified as he moved into the South China Sea attaining typhoon intensity by 1200. Aircraft reconnaissance penetrating the 30 mi wide eye at 03/0843 found 65 kn winds at the surface and 68 kn winds at 700 mb. Ike continued to track steadily to the northwest reaching an intensity of 115 kn at 1800 on the 4th. Ike gradually lost intensity from this point on, due to the proximity of land restricting the inflow, and shearing from a trough passing to the north.

Ike transited across Hainan Island on 5 September still packing winds of 70 to 80 kn. Shortly after 0000 on the 6th, Ike crossed the coast of mainland China, as a tropical storm, approximately 60 mi south-southweast of Nan-Ning. News reports indicate Ike was responsible for at least 13 deaths in China. Extensive flooding and crop damage were also reported as Ike moved inland and dissipated.

TYPHOON KELLY (15W)

Typhoon Kelly was quite representative of the first half of the 1984 season which was characterized by numerous high latitude, fast-moving systems. This typhoon developed at the southern end of a shear line and displayed some erratic movement during its formative stages before accelerating to the north-northwest towards a mid-level cut-off low. During the last phase of its life, Kelly recurved very sharply to the northeast and transitioned into an extratropical system.

During the first week of September, a strong frontal system moved across the North Pacific Ocean and left in its wake a quasistationary shear line extending between 20°N, 170°E and 35°N, 180°E. On 11 September the southern portion of the shear line became detached and began to take on tropical characteristics.

During the next 2 days the disturbance slowly developed as the associated convection increased in organization. At 0000 on the 13th, an exposed low-level circulation was observed on satellite imagery west-northwest of the main convection, and an aircraft investigative mission was requested for the following morning. Throughout the evening the system continued to develop with the convection showing a considerable increase in organization.

As long as Kelly stayed below tropical storm strength it moved slowly. Satellite fixes on the 13th indicated Kelly moved in a cyclonic loop about its point of origin. However, after it became a named storm, Kelly accelerated to the north and eventually to the northwest as it was caught in the southerlies between the mid-Pacific High and the inflow pattern about the cutoff LOW. Because of its relatively high latitude, Kelly entrained cold air into its circulation almost from the start, and was slow to intensify.

Kelly slowed and reached maximum intensity on the 16th. Then suddenly, under the influence of the mid-latitude westerlies just to the north, it abruptly turned and accelerated to the northeast. Although JTWC forecasts indicated recurvature to the northeast would occur, it was not forecast to begin until Kelly reached 35°N. Kelly weakened very rapidly after recurvature as the convection began to be sheared. By 1200 on the 17th the storm had started to loose its tropical characteristics.

In this phase, Kelly began to demonstrate intensity anomalies frequently observed in storms becoming extratropical. The low central pressures observed did not correspond well with the relatively weak winds found by aircraft reconnaissance. On the other hand, since the central convection had nearly disappeared, the Dvorak intensity model estimated winds significantly lower than what was observed by aircraft. By the 18th Kelly had completed its extratropical transition and the final warning was issued. The remnants of Kelly continued to the northeast and were locatable on satellite imagery until the 21st. By then the system was east of the International Dateline and moving into the Gulf of Alaska.

TYPHOON OGDEN (19W)

Typhoon Ogden was the first of a series of eight tropical cyclones during the month of October which established a new record for northwest Pacific tropical cyclone activity for that month. Ogden like the two storms before it, moved almost due north from the time it developed until it began to recurve. Ogden had great difficulty in becoming vertically aligned and would probably never have attained typhoon intensity if it had not accelerated after recurvature thereby adding the translation speed of movement to the storm's wind field.

The disturbance that developed into the eighth typhoon of the season was initially detected as a weak surface circulation west of Truk on 3 October. The disturbance moved to the northwest over the next 18 hours and became part of the eastward extension of the resurging southwest monsoon trough.

The monsoon trough began to extend northwestward on the 4th as it had a week earlier when tropical storms Maury and Nina developed. As the circulation became embedded in the trough, the disturbance followed the trough orientation and tracked to the northeast. Some poorly organized convection associated with the surface circulation could now be detected on satellite imagery. Upper-level flow up to this time was weak but generally diffluent. An upper-level anticyclone was observed to be developing over the disturbance on the 5th. Early on the 6th, the convection moved slightly southwest and continued to increase in size and organization. This brought the low-level circulation in closer proximity to the mid and upper-level features. At 0600 on the 6th a ship near the disturbance's center reported a 1002 mb pressure to confirm earlier analysis.

The first of seven aircraft reconnaissance flights into Orgden occurred early on 6 October. A surface center was not located but a sharp low-level trough oriented northeast to southwest with an MSLP of 1000 mb was evident. The second aircraft reconnaissance mission on the 6th closed-off a circulation center with an MSLP of 999 mb and reported 15 kn winds near the broad center. Winds of 35 kn were found approximately 170 mi east-northeast of the center associated with the tight pressure gradient between the developing Ogden the subtropical ridge to the northeast.

Ogden tracked around the southwest periphery of the mid-Pacific ridge. The ridge was retreating eastward in advance of a mid-latitude trough approaching from Japan. Although the first four JTWC warnings forecast eventual recurvature to the northeast, the actual recurvature was much sharper than anticipated, with significant acceleration occuring during the first 24 hr of the forecast period. This was due to the mid-latitude trough moving east faster than anticipated, resulting in a more rapid retreat of the mid-Pacfic ridge. This quickly put Ogden under a southwesterly steering flow.

Ogden obtained tropical storm intensity on the 7th. At this time, Ogden was already accelerating to the northeast. Part of the storm's intensification during the next 30 hr would be a result of the forward translational speed being added to the true wind speed. This would consistently put the stronger winds in the southeast semicircle.

The only land affected by Ogden was Marcus Island. Ogden passed just to the east of the island at approximately 08/0200. The west semicircle o the storm, and as result, no damage was reported. The intensifying surface center passed very close to the island.

At 1200Z on 8 October, the midlatitude westerlies began to accelerate Ogden to the northeast in earnest and Ogden began its transition to an extratropical LOW as it attained typhoon intensity. A combination of the extratropical transition and a 20 kn northeast movement contributed to an expanded asymmetric wind field and to the typhoon force winds in the southeast semicircle. Aircraft reconnaissance at 2132 on the 8th reported 70 kn surface winds 30 mi from the surface center in the southwest and southeast quadrants. Ogden weakened to tropical storm strength approximately 24 hr after it obtained typhoon strength, even though maximum sustained winds of 77 kn were indicated from satellite imager. It was apparent on satellite imagery at 0000 on 10 October that Ogden had lost all convection and had completed its extratropical transition. It still supported 55 kn winds and had a 32 kn northeast movement.

TYPHOON PHYLLIS (20W)

Typhoon Phyllis was the first of four significant tropical cyclones to develop in the monsoon trough during a two day period. Three of these would form in WESTPAC, with the fourth, Tropical Cyclone 02B developing in the Bay of Bengal. Of the four, Phyllis was by far the strongest, reaching a maximum intensity of 80 kn. However, despite its strength, Phyllis caused no reported damage as it remained over water throughout its life.

As an intensifying typhoon, Ogden began to accelerate to the northeast on 7 October, a broad area of troughing and low-level convergence persisted in its wake. By late on the 7th, the seedling of Phyllis was being analyzed as a weak surface circulation embedded in the trough east of Guam.

Although surface synoptic data was sparse near the circulation northeast of Guam, satellite imagery during the 9th and into the 10th indicated that a compact circulation was developing. The first warning on Phyllis was issued at 0000 on the 11th after satellite imagery indicated the disturbance had intensified furyher and now supported winds of 35 kn. By now Phyllis had nearly detached from the trough and would soon begin to accelerate to the north. During the next 24 hr Phyllis intensified rapidly reaching typhoon strength by the 12th. The upgrade to typhooon status was based upon reports from reconnaissance aircraft and from Dvorak intensity analysis of figure 17.

Phyllis continued to strengthen reaching a

Figure 17.-- Phyllis at the time Dvorak analysis indicated typhoon intensity. DMSP Image.

maximum intensity of 80 kn 12 hours later. At the time Phyllis attained its peak intensity, it was located under a well-defined synoptic scale anticyclone. This anticyclone provided good outflow to all quadrants of the storm. As Phyllis moved north, however, the anticyclone remained quasi-stationary near Marcus Island. As a result, less than 12 hr later Phyllis would enter the 50 to 70 kn westerly flow and begin to shear and weaken.

Typhoon Phyllis maintained a predominantly northward track from the time it separated from the monsoon trough until it began to dissipate. As Phyllis began to move north, a digging mid-latitude shortwave formed a vigorous cut-off low south of Honshu. This allowed the ridge east Phyllis to rapidly build back northward, keeping Phyllis under a strong southerly steering flow.

As Phyllis passed north of 25° N, the cut-off LOW with its associated frontal system began to accelerate to the northeast. At the same time, Phyllis becan to encounter the strong upper-level westerlies and the convection was displaced to the east of the low-level circulation. Phyllis responded by weakening at an even faster rate than it had earlier intensified.

TYPHOON THAD (24W)

Typhoon Thad developed southeast of Guam just as tropical depression 23W was dissipating several hundred miles to the northwest. Unlike its predecessor, Thad developed under favorable upper-level environment which permitted further intensification. As Thad developed, it tracked steadily to the north-northwest before recurving to the northeast. The typhoon's movement was well forecast except during the initial stages.

Synoptic data at 0000, 18 October confirmed what the last aircraft reconnaissance mission into tropical depression 23W had observed a few hours earlier; that a broad surface circulation was developing near Truk. This circulation was underneath the developing convection and on the eastern end of the monsoon trough. Synoptic data south of the trough axis indicated the southwest monsoon was intensifying with numerous 20 to 30 kn west winds being reported.

Over the next several hours, the convection rapidly consolidated. In addition, satellite imagery and synoptic data showed an anticyclone was developing aloft providing good outflow to all quadrants.

At 0728 on the 19th the first aircraft reconnaissance flight into the center of the distrubance was made. It located Thad almost 180 mi east of Guam with an MSLP of 990 mb. This meant that the storm would now safely clear Guam. On the 20th a well-developed Thad continued to move to the northnorthwest.

Thad intensified steadily from the time JTWC went into warning status at 0000, 19 October until it reached its peak intensity of 120 kn at 1800 on the 21st (fig. 18). By this time Thad had begun to recurve and link-up with a mid-latitude trough. After maintaining the 120 kn intensity for approximately 12 hr, Thad began a slow weakening trend which continued until the storm went extratropical. During this period, Thad accelerated from 16 kn to 30 kn as it became embedded in the westerlies. As would be expected with the storms that accelerate after recurvature, the strongest surface winds were consistently observerd in the southeast semicircle.

On the 23rd, Thad lost most of its convection with an exposed low-level

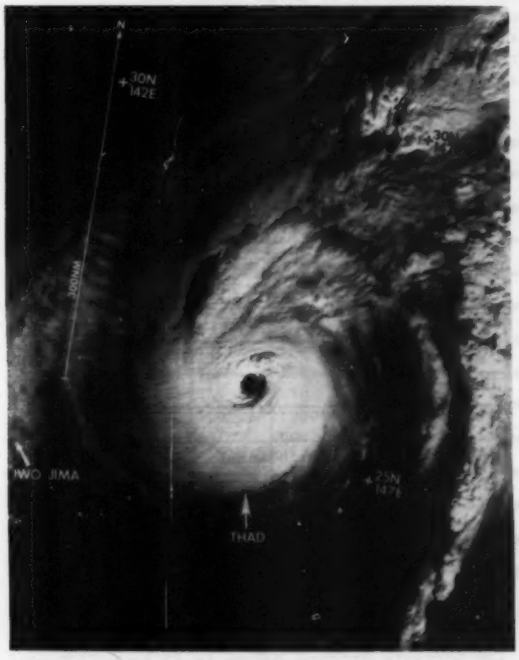


Figure 18.-- Visual image of Thad at 120 kn on 22 October, 0002. DMSP imagery.

circulation center visible on satellite imager. The final warning on this system was issued by JTWC at 0000 on the 24th.

SUPERTYPHOON VANESSA

Super typhoon Vanessa, the first super typhoon of the 1984 season, also developed into the most intense storm of the year. At peak intensity Vanessa had an MSLP of 879 mb, only 9 mb above the record 870 mb observed in super typhoon Tip (1979). Except for a brief period when the storm brushed Guam, Vanessa remained clear of land and generally posed a threat only to shipping.

Super Typhoon Vanessa originated in the Near Equatorial Trough southeast of Ponape 3 days after typhoon Thad formed some 700 mi further to the west. The disturbance was initially detected on 20 October as an area of convection near 4°N, 163°E.

During the 21st and into the 22nd, the area of convection slowly increased in organization as the disturbance moved northwest to just north of Ponape. Sparse synpoptic data confirm the presence of a 10 to 15 kn surface circulation. By now an upper-level anticyclone had developed, providing good outflow. The first warning on Vanessa was issued at 1800 on 22 October when analysis of satellite imagery resulted in an estimate that the disturbance now supported surface winds of 35 kn.

From beginning to end, Vanessa followed a very climatological track becoming one of the "great-recurver" storms of 1984. From the time it attained depression strength until it began to recurve, it moved almost due west-northwest. After recurving south of Okinawa, Vanessa underwent a complex transition into an extratropical LOW east of Japan.

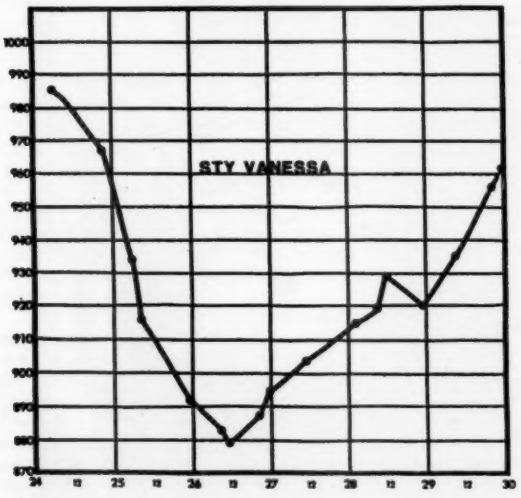


Figure 19.--Time cross-section of Vanessa's sea-level pressure measured by reconnaissance. The pressure dropped 100 mb in 48 hr to 879 mb at 1114, 26 October. From JTWC 1984 Annual report.

Vanessa's intensity came very close to equallying the records established by super typhoon Tip in 1979 (cover photo). Figure 19 shows the MSLP versus time for Vanessa as obtained by reconnaissance aircraft. The pressure dropped 100 mb in a 48 hr period to reach a minimum of 879 mb at 1114 on the 26th. This is only 9 mb higher than the 870 mb recorded in Tip. (These pressures convert to 155 kn and approximately 165 kn for Vanessa and Tip, respectively, using the Atkinson and Holliday (1977) pressure-wind relationship).

The initial warning forecast Vanessa to move west-northwest and pass over Guam within 48 hr as a 65 kn typhoon. The accuracy of the first forecasts gave the military and civilian communities on Guam sufficient time to properly prepare. Consequently there was little structural damage on the island and no personal injuries when Vanessa did approach as an 80 kn typhoon. Vanessa's closest point of approach to Guam was 90 mi to the south-southwest at 1100 on the 24th. Sustained wind above 30 kn were recorder at numerous locations on the island with a peak gust of 59 kn recorded at the Naval Oceanography Command Center building on Nimitz Hill. The only significant damage on Guam occurred to vegetation. An estimated $1.7 million worth of crops were lost, principally bananas.

Vanessa continued to intensify and move west-northwest after it passed south of Guam. The dominate synoptic feature was the subtropical ridge north of Vanessa which redeveloped in the wake of Typhoon Thad. Vanessa moved along the southern side of the ridge for nearly 5 days before recurving. It was just prior to recurvature, at 1200 on the 26th that a peak intensity of 155 kn was attained. The ARWO flying the 26/1114 fix mission that observed the 879 mb MSLP, described the 10 mi circular eye as exhibiting a "fishbowl effect" with the convection in the eyewall spiralling vertically to the point of resembling corkscrews. During this flight, at a 700 mb height of 2022 m, the 700 mb temperature within the eye was an exceptionally high 30°C. Vanessa remained a super typhoon from 25/1800 to 28/0000.

The recurvature which eventually took place on the 27th and 28th was intially forecast on the 25/0000 warning. A frontal system over eastern China was identified as the mechanism for recurvature. Vanessa turned to the northeast at 20°N. At no point during this period was typhoon Warren in the South China Sea considered to be a factor in Vanessa's movement since Vanessa was the dominant storm both in size and strength.

The final phase of Vanessa's life was a complex transition to an extratropical LOW. Interaction with the front began shortly after recurvature. Post-analysis indicates that extratropical transition was completed by 1200 on the 30th as satellite imagery showed no convection was present. Vanessa transitioned to a storm force LOW along the front and rapidly moved off to the northeast.

TYPHOON WARREN (26W)

Typhoon Warren was the most erratic moving tropical cyclone of 1984. It made both a cyclonic and anticyclonic loop and varied in speed from quasi-stationary for 12 hr to 8 kn. Warren's erratic movements were due to interactions with eastward moving mid-latitude troughs and super typhoon Vanessa and due to its location in the monsoon trough.

The precursor of Warren appeared late on 17 October as an area of poorly organized convection at the training end of a shear line approximately 300 mi northeast of Mindanao. Aircraft reconnaissance investigated the area on the 19th and found a broad weak surface circulation with MSLP of 1006 mb.

Over the next several days the surface circulation weakened and moved west-southwest along the trough axis across the Philippines and entered the South China Sea on 22 October. On the 23rd the disturbance rapidly developed and was upgraded to a tropical storm.

Between the 24th and 27th Warren moved erratically. It did a small cyclonic moved loop on the 24th and 25th, before resuming a slow westward course followed by a turn to the north and a 12-hour quasi-stationary period between 26/1200 and 27/0000. This erratic movement was partially due to Warren's remaining embedded in the monsoon trough and the passage of a mid-latitude trough to the north.

During this period, despite the strong upper-level easterly winds which kept nearly all the convection west of the low-level center, Warren strengthened to typhoon intensity. Aircraft reconnaissance on the 26th found a band of 60 to 70 kn surface winds in the south semicircle of Warren. These winds were the result of the southwest monsoon enhancing Warren's circulation. Warren maintained this minimum 65 kn typhoon intensity through 1800 on the 28th.

Warren became quasi-stationary on the 26th. At this time super typhoon Vanessa (located some 960 mi to the east of Warren in the central Philippine Sea) was moving towards the northwest. Warren now came under the influence of Vanessa's large inflow and a mid-latitude trough passing to the North. Warren responded by turning to the east-northeast. This placed the Philippine Islands north of 14°N including Clark AB and the Subic Bay Naval Facilities in imminent danger of being hit by Warren. As a result, all Navy and Air Force Bases in the region were placed in Condition of Readiness I early on the 28th. Fortunately, Warren's interaction with Vannessa and the mid-latitude trough was short-lived sparing the Philippines a direct hit. On 28 October, Warren slowed and commenced an anticyclonic turn back to the west. At its closest point of approach Warren was 120 mi west-northwest of Clark AB. Warren completed its turn to the west on 29 October. The highest wind reported at Clark AB was 22 kn with the total rainfall on 28 and 29 October reaching 8.74 in. No significant damage was reported at any of the military bases.

Other Coastal areas and marine interests were not nearly as fortunate. Heavy rains caused landslides in several coastal towns killing at least 42 people. High seas capsized and sank the inter-island passenger ferry, VENUS (746 tons) on 28 October off Torrijos and Bondoc Peninsula. About 36 people were killed but at least 213 passengers were saved. In addition, a 930 ton ship, the LORENZO CONTAINER VIII was sunk on 28 October near 14°N, 121°E with eight crew members listed as missing.

Warren crossed the central Vietnam coast on 1 November with moderate to heavy rain forecast. The combination of the northeast monsoon and dissipating surface circulation just offshore resulted in 30 to 35 kn winds along the Vietnam coast.

TYPHOON AGNES (27W)

Typhoon Agnes was the first of three tropical cyclones to develop during the month of November. It was also the last storm of the season to directly hit the Philippines. From the time of the first warning until it made landfall over centeral Vietnam, Agnes moved rapidly on a nearly straight west-northwest course.

The system that eventually developed into typhoon Agnes began as an isolated area of weak convection near the Equator on 28 October. The system slowly developed during the next 3 days as the area of convection and associated weak circulation moved northwest to near 4°N. Late on the 31st, satellite imagery revealed that a significant increase in convection and organization was taking place. The first aircraft reconnaissance mission found a closed circulation with maximum surface winds of 50 kn. Analysis of satellite imagery conducted just prior to the flight had indicated that only 35 kn winds were to be expected. The first warning on Agnes as a tropical storm was issued at 0600, 1 November.

From the time the disturbance was initially detected Agnes had moved slowly to the northwest. By early on 1 November, Agnes had moved far enough north to be influenced by the easterly flow along the south side of the broad mid- to low-level subtropical ridge which now extended from the dateline west to the coast of Vietnam. This ridge and its associated easterly steering flow persisted throughout the life of typhoon Agnes and kept the storm on a west-northwest track from November until it dissipated over Vietnam 6 days later.

As Agnes transited the Philippine Sea it steadily intensified reaching a peak intensity of 120 kn at 1800 on the 4th. This peak intensity occurred just prior to Agnes making landfall 10 mi south of Borongan on the central Philippine Island of Samar.

Agnes weakened as she crossed the central Philippines, but due to her rapid speed of movement was able to maintain typhoon intensity. After emerging in the South China

Sea, Agnes once again intensified, this time to 100 kn. Agnes maintained this intensity until she made landfall 20 mi north of Que-Nhon, Vietman at 1100, 7 November. After landfall Agnes continued to track to the west-northwest and rapidly weakened.

Typhoon Agnes caused substantial damage and loss of life when she crossed the Philippine Islands. Storm surge flooding of low-lying coastal areas on the islands of Samar and Leyte was particularly severe. In addition, heavy rainfall caused extensive flooding. The winds, floods and mudslides combined to leave over 350,000 homeless. At least 564 people are known dead as a result of the storm. When the number dead are combined with the number of people reported missing, the final death count is expected to be near 1,000. News reports indicated that the damage exceeded 600 million pesos (30 million U.S. dollars).

When Typhoon Agnes made landfall on Vietnam 3 days later, there was additional destruction of property and loss of life. Heavy rains brought flooding which severely affected the rice harvest and winter crop cultivation.

SUPER TYPHOON BILL (28W)

The second and last super typhoon of the 1984 season led a rather unusual life. After forming east of Guam, it made a small cyclonic loop before heading to the west-southwest. Two days later, Bill passed just to the south of Guam. After causing some damage on the island of Guam, Bills entered the Philippine Sea and turned to the west-northwest. Although it was expected to recurve to the northeast and follow a track similar to that of super typhoon Vanessa, due to a complex steering environment including interaction with typhoon Clara, Bill instead turned to the southeast before eventually dissipating east of the Philippines. Although this track is unusual, it is not uncommon for late season storms to move erratically for at least a portion of their life.

Super typhoon Bill originated as an area of convection on 7 November near 14°N 154°E. The convection was at the trailing end of an eastward moving cold front and this may have supplied some low-level vorticity which contributed to the rapid development of the disturbance.

The first of a total of 35 aircraft reconnaissance flights flown against Bill on the 18th and found the disturbance's circulation center but obseerved surface winds of only 20 kn. The system showed continued development and the first warning was issued.

From the 8th until the 10th, Bill slowly tracked in a 25 mi wide cyclonic loop and continued to strenghthen. At 0000 on 10 November, reconnaissance aircraft reported that Bill had intesified to a 50 kn tropical storm with a MSLP of 990 mb.

Bill attained typhoon strength on the 10th. The weak steering flow which had been present was replaced by easterly flow as the subtropical ridge strengthened to the north of the storm. At approximately 0600 Bill completed its cyclonic loop and started to move to the west and then southwest on a course that would eventually bring the typhoon to the southern tip of Guam. Bill accelerated and gradually intensified. Bill was forecast to pass within 30 mi of Guam.

Typhoon Bill passed the southern tip of Guam at 1630 on the 12th a distance of 12 mi. On the island, a maximum wind of 63 kn was recorded at the National Weather Service Station at 1658 on the 12th, with a gust of 84 kn recorded at Reserve Craft Beach in Apra Harbor. Typhoon Bill caused some damage on Guam, particularly to agricultural commodities. Banana trees that had been slightly damaged during the passage of super typhoon Vanessa were completely destroyed by Bill. Total crop damage was estimated at $7,707,911. Some minor flooding also occurred but not personnel injuries were reported. Electrical power was out in certain sections of the island for several days.

Bill entered the Philippine Sea late on the 12th moving west and intensifying. In the 24 hr period between 13/1200 and 14/1200, the MSLP dropped 54 mb to 912 mb and the wind speed increased from 95 kn to 125 kn (fig. 21). The pressure continued to drop for another 12 hr, with aircraft reconnaissance reporting a MSLP of 909 mb. This was the lowest pressure reported in Bill. Bill attained super typhoon strength at approximately 1800 on the 14th which he then maintained for 12 hr.

Bill turned to the northwest on the 14th. It now appeared that Bill was starting to move around the western end of the subtropical ridge. What was initially expected to be a simple recurvature scenario would soon become a complex interaction between Bill, the approaching typhoon Clara, the mid-latitude westerlies, and the northweast monsoon. These factors would eventually cause Bill to weaken, double back on its present track and eventually dissipate.

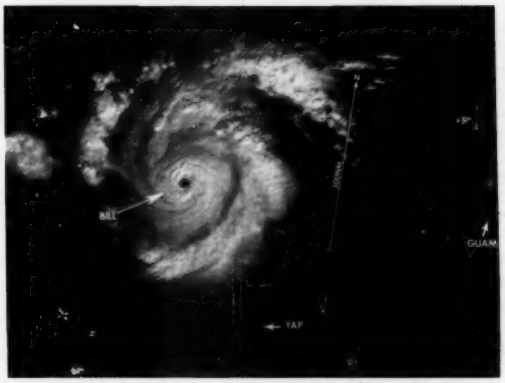


Figure 21.-- Bill displays a beautiful eye as he is rapidly intensifing, 0044, 14 November. DMSP imagery.

Bill slowed down as he moved to the northwest and began to weaken as it encountered strong upper-level westerlies which disrupted its outflow and sheared the convection.

Bill tracked west-northwest to northwest from the 15th to the 18th when he curved to the northeast. Clara's large low-level circulation then turned Bill to the southeast. On the 19th reconnaissance found a weak 997 mb cyclone. On the 20th winds of 40 to 55 kn were measured as Clara recurved to the northeast. On the 21st Bill made a small cyclonic loop and was no longer identifiable by the 22nd.

TYPHOON CLARA (29W)

Typhoon Clara was the last significant tropical cyclone to develop during the month of November. It developed into a textbook, late-season recurver and was noteworthy due to its effect on super typhoon Bill.

Clara began on 11 November as a large, low-latitude disturbance in the eastern Caroline Islands. It was located by surface synoptic data before it was identified in satellite imagery. By the 13th a very broad area of convection was associated with the circulation.

As Clara intensified she developed into a large circulation. On the 15th, Clara controlled as much inflow as Bill, and by late on the 16th was clearly the dominant of the two storms. Progress along its track was typical of a well-behaved fast moving typhoon, and anticipated well in advance by JTWC. Typhoon Clara recurved just east of 132°E. As Clara recurved, it passed within 500 mi of the weakening super typhoon Bill. This proximity to Bill disrupted Clara's outflow and resulted in a slight weakening. Late on the 19th, as Clara recurved to the northeast she reintensified to 105 kn. This was just 5 kn less than the peak intensity of 110 kn recorded prior to recurvature.

Clara completed recurvature by the 20th and was about to begin extratropical transition with a frontal system to the northeast. This transition was of the complex variety in which the typhoon merges with an existing front and becomes a wave on the front and usually accelerates to the northeast. In this process the typhoon loses all of its convection and tropical characteristics but still retains a strong low-level wind field.

As Clara accelerated to the east-northeast, she passed to the north of Iwo-Jima which put the island in the dangerous semicircle of the typhoon. Sustained winds of 40 kn with gusts to 63 kn were reported during Clara's passage. However, no known damage was sustained on the island.

TYPHOON DOYLE (30W)

Typhoon Doyle was the final tropical cyclone of the 1984 season and the only one to develop during the month of December. Doyle followed a typical recurvature track and remained over open water throughout its lifetime. The tropical disturbance that was to become Doyle first appeared as an area of convective activity near 5°N, 156°E on 1 December.

Aircraft reconnaissance early on the 3d was unable to locate a surface circulation, but did find a trough with an MSLP of 1004 mb. The system continued to show signs of increased orgnization. On the afternoon of the 4th, aircraft reconnaissance indicated that the MSLP had dropped to 1001 mb and that 25 kn surface winds were now associated with the disturbance.

An investigative flight into Doyle early on the 5th was finally able to locate the storm's center, observing 40 kn surface winds and measuring a central pressure of 994 mb. The surface center was very small- measuring a mere 5 mi in diameter.

During the next 48 hr, Doyle slowly intensified. Late on 6 December the central pressure was measured at 973 mb, a drop of 18 mb in just 12 hr. Maximum sustained surface winds 90 kn were observed on the north side of the storm where the easterly trades were enhancing Doyle's circulation. Doyle was upgraded to typhoon strength at 0000 on the 7th. Accompanying this intensification was a change in movement to a more northwesterly track.

At 2047 on the 7th the MSLP had decreased to 935 mb, a fall of 43 mb in 24 hr. Maximum sustained winds reported by the ARWO at this time were 110 kn. Doyle's central sea-level pressure began to rise - reaching 993 mb at 2037, 9 December (a rise of 58 mb in 48 hours). An unusal feature of Typhoon Doyle was the way the maximum surface winds lagged the occurrence of its MSLP. Typhoon Doyle reached a maximum intensity of 125 kn at 0000 on the 9th some 27 hours after the lowest minimum sea-level pressure was recorded.

Between 09/1200 and 10/0000, Doyle turned to the north and rapidly weakened from 95 kn to 45 kn. Doyle weakened more gradually while accelerating to the northeast. The final warning was issued on the 11th.

NORTH INDIAN OCEAN TROPICAL CYCLONES, 1984

Extracted from the Annual Tropical Cyclone Report, 1984, U.S. Naval Oceanographic Command Center, Joint Typhoon Warning Center, Guam, Mariana Islands.

Tropical cyclone activity in the North Indian Ocean was nearly normal during 1984. Four storms originated in this area as compared to the annual average of 4.4. Tables 5 through 7 provide a summary of North Indian Ocean tropical cyclone activity for 1984 as compared to earlier years. Figure 22 indicates the storm tracks.

TROPICAL CYCLONE 01A

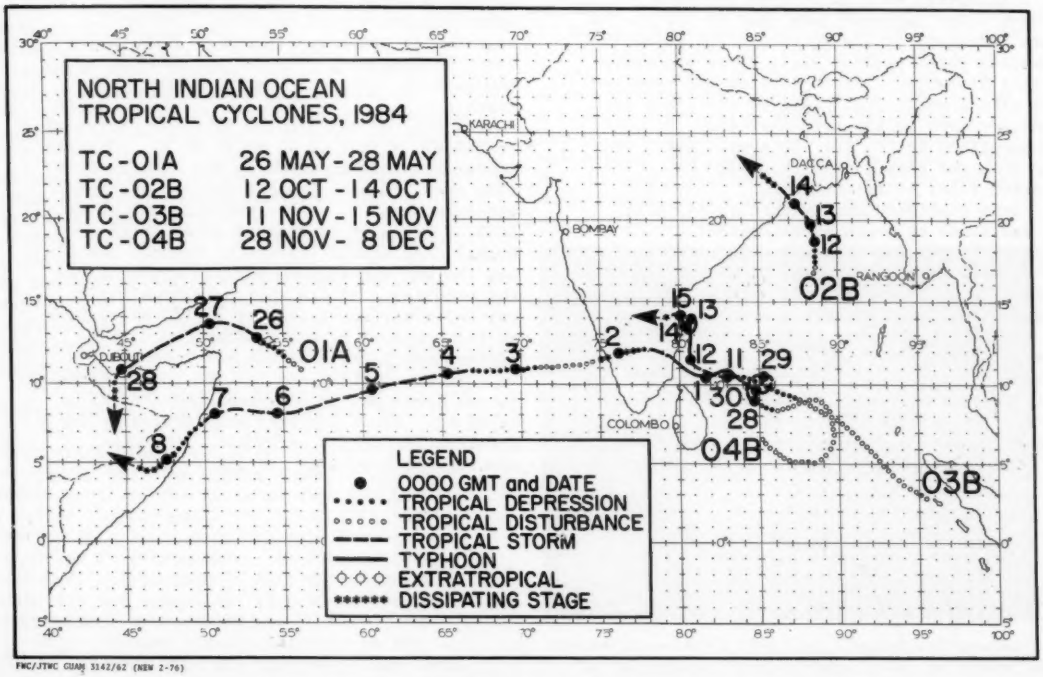
Tropical Cyclone 01A, the only tropical cyclone to develop in the North Indian Ocean during the Spring transition season, distinguished itself by its non-climatological track. After developing in the western Arabian Sea, tropical cyclone 01A turned to the west-southwest and transited through the Gulf of Aden rather than moving to the north or northwest along the climatologically favored track and making landfall along the east coast of the Arabian peninsula. This is the only tropical cyclone of record to transit through the Gulf of Aden.

The disturbance which eventually developed into Tropical Cyclone 01A was first detected on 23 May as an area of strong convection centered approximately 180 mi. southeast of Socotra. The disturbance moved slowly northwestward during the next 36 hr. with a gradual increase in organization. Satellite imagery indicated that a small but well organized low-level circulation was developing. Throughout this period, synoptic data was unable to confirm the presence of a surface circulation. Based on a Dvorak intensity analysis which estimated that surface winds of 35 kn were present, a warning was issued for 0600, 26 May.

Tropical cyclone 01A remained a compact system throughout its life. Even at its maximum intensity of 45 kn between 0000 and 0600 on 27 May, the radius of greater than 30 kn winds was estimated to be only 60 mi. The small size of Tropical cyclone 01A coupled

Table 5.-- North Indian Ocean Tropical Cyclones, 1984

TROPICAL CYCLONE	PERIOD OF WARNING	CALENDAR DAYS OF WARNING	NUMBER OF WARNINGS ISSUED	MAXIMUM SURFACE WIND (KT)	ESTIMATED MSLP (MB)	BEST TRACK DISTANCE TRAVELED (NM)
1. TC 01A	26 MAY - 28 MAY	3	9	45	990	810
2. TC 02B	12 OCT - 14 OCT	3	8	45	980	380
3. TC 03B	11 NOV - 15 NOV	5	16	85	975	719
4. TC 04B	28 NOV - 08 DEC	11	34	75	973	2662
	1984 TOTALS:	22	67			



FNC/JTWC GUAM 3142/62 (NEW 2-76)

Figure 22.-- North Indian Ocean tropical storm tracks, 1984.

Table 6.--North Indian Ocean statistics, 1984

NORTH INDIAN OCEAN	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1984 TROPICAL CYCLONES	0	0	0	0	1	0	0	0	0	1	2	0	4
1975-1984 AVERAGE	.1	-	-	.1	.7	.6	-	.1	.3	1.0	1.4	.3	4.4
CASES	1	-	-	1	7	6	-	1	3	10	14	3	44

FORMATION ALERTS: 4 out of 10 Formation Alerts developed into significant tropical cyclones. Tropical Cyclone Formation Alerts were issued for all significant tropical cyclones that developed during 1984.

WARNINGS:

Number of warning days:	22
Number of warning days with two tropical cyclones in region:	0
Number of warning days with three or more tropical cyclones in region:	0

Table 7.-- Frequency of tropical cyclones North Indian Ocean

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1971*	-	-	-	-	-	0	0	0	0	1	1	0	2
1972*	0	0	0	1	0	0	0	0	2	0	1	0	4
1973*	0	0	0	0	0	0	0	0	0	1	2	1	4
1974*	0	0	0	0	0	0	0	0	0	0	1	0	1
1975	1	0	0	0	2	0	0	0	0	1	2	0	6
1976	0	0	0	1	0	1	0	0	1	1	0	1	5
1977	0	0	0	0	1	1	0	0	0	1	2	0	5
1978	0	0	0	0	1	0	0	0	0	1	2	0	4
1979	0	0	0	0	1	1	0	0	2	1	2	0	7
1980	0	0	0	0	0	0	0	0	0	0	1	1	2
1981	0	0	0	0	0	0	0	0	0	1	1	1	3
1982	0	0	0	0	1	1	0	0	0	2	1	0	5
1983	0	0	0	0	0	0	0	1	0	1	1	0	3
1984	0	0	0	0	1	0	0	0	0	1	2	0	4
1975-1984 AVERAGE	.1	-	-	.1	.7	.6	-	.1	.3	1.0	1.4	.3	4.4
CASES	1	0	0	1	7	6	0	1	3	10	14	3	44

* JTWC warning responsibility began on 4 June 1971 for the Bay of Bengal, east of 90E. As directed by CINCPACFLT, JTWC issued warnings only for those tropical cyclones that developed or tracked through that portion of the Bay of Bengal. Commencing with the 1975 tropical cyclone season, JTWC's area of responsibility was extended westward to include the western portion of the Bay of Bengal and the entire Arabian Sea.

with the sparsity of synoptic data in the area precluded any verification of surface intensity estimates. Intensity estimates on this system were based entirely on Dvorak satellite analysis.

Tropical cyclone 01A moved northwestward until late on the 26th, when it turned to the west-southwest and entered the Gulf of Aden in response to a strong subtropical ridge over Saudi Arabia. It transited up the Gulf of Aden until landfall at 0300 on 28 May, approximately 35 mi west of Berbera, Somalia. After making landfall, Tropical cyclone 01A moved inland over Somalia and dissipated. There were no reports of damages or injuries from this system.

TROPICAL CYCLONE 02B

Tropical cyclone 02B, the first tropical cyclone to develop in the North Indian Ocean during the Fall transition season, led a rather uneventful life. Tropical cyclone 02B was first detected early on 10 October as a broad area of convection in the north-central Bay of Bengal. During the day the convection showed improved organization with cirrus plumes indicating an upper-level anticyclone existed over the disturbance. No surface synoptic data was available in the area; however, curvature of the low-level clouds indicated a developing low-level circulation was present. Dvorak intensity analysis of the 1800 imagery estimated that surface winds of 30 kn were present in the system.

During the next 2 days the disturbance developed a broad circulation covering the head of the Bay of Bengal and intensified slowly. Upper-level support remained favorable for further intensification and the only inhibiting factor for development was the proximity of the disturbance to land which restricted the low-level inflow. Although tropical cyclone 02B formed in the monsoon trough, most of the flow from the southwest monsoon was being drawn into Tropical Storm Susan (22W) which was developing in the South China Sea. If Susan had not been present, tropical cyclone 02B may have developed into a more potent system.

The developing cyclone tracked slowly north until the 12th when a turn to the northwest began. At 1800 the first warning was issued. Satellite imagery indicated that the system had intensified significantly over the past 24 hr and was now supporting winds of 45 kn. Once again due to lack of synoptic data, the intensity estimate was based solely on Dvorak analysis of satellite imagery. Tropical cyclone 02B maintained this intensity for the next 12 hr until strong upper-level easterlies began to shear the convection to the west on 13 October (fig. 23). This started a weakening trend which continued until dissipation.

As it weakened, tropical cyclone 02B continued moving to the northwest and increased its forward speed. At about 0300, 14 October it made landfall on the coast of India approximately 10 mi south of Balasore. The system weakened rapidly over land with the final warning being issued at 1200. Although some heavy rains accompanied this storm as it made landfall there have been no reports of damage.

TROPICAL CYCLONE 03B

Tropical Cyclone 03B, the second cyclone to form in the North Indian Ocean during the Autumn transition season, developed into the

Figure 23.--Tropical cyclone 2B near maximum intensity at 0446, 13 October. DMSP imagery.

most intense of all 1984 North Indian Ocean storms. The storm was responsible for at least 430 deaths and has been called the worst tropical cyclone to affect the central east coast of India in 15 yr.

The disturbance that would eventually develop into tropical cyclone 03B, was first noticed late on 5 November as a broad area of poorly organized convection west of Sumatra. Over the next few days the disturbance moved northwest. Although the system showed periodic convective flare-ups, there was no permanent significant increase in organization until 9 November. By then a well-defined low-level circulation center was visible on satellite imagery. During the 9th and into the 10th, the disturbance moved to the west-northwest with only slow development noted. At that time it was thought the disturbance might make landfall over the southeast coast of India before developing into a significant tropical cyclone. However, that was not to be the case.

Late on the 10th, analysis of satellite imagery indicated that the overall convection and organization of the disturbance was increasing. Dvorak intensity analysis indicated that 30 kn winds were present.

Less than 4 hr later, JTWC received a Dvorak intensity analysis from the Air Force Global Weather Central (AFGWC) which indicated the disturbance had intensified rapidly and now supported winds of 55 kn. The first warning on Tropical Cyclone 03B was issued at 1200 on the 11th.

Since tropical cyclone 03B was firmly embedded in the southeasterly flow south of the ridge axis, the initial forecasts called for continued west-northwest movement, with dissipation over India within 36 hr. However, tropical cyclone 03B was to take a different course. Responding to the flow around the periphery of the ridge, the storm curved to the north and moved into the mid-level col area, lost all steering, and began an erratic movement. It took at least one clockwise loop (and perhaps a second) before finally drifting slowly to the northwest towards India.

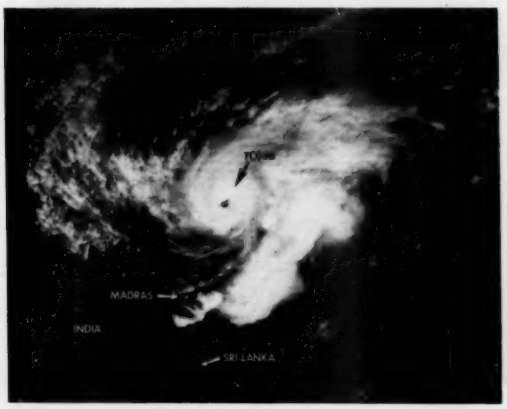


Figure 24.-- Tropical cyclone 03B near maximum intensity at 0427, 13 November. DMSP imagery.

As the storm moved north on the 12th, it deepened rapidly attaining a peak intensity of 85 kn by 1800. During this development stage, the system was vertically aligned with the upper-level anticyclone. From early on the 12th until the 14th, a 6 to 15 mi wide eye was observed on satellite imagery (fig. 24).

On 14 November, strong upper-level southwesterlies began to exert pressure on the storm. As a result, the convection began to be displaced to the northeast. Gradual weakening followed under this shearing environment until the storm made landfall where final dissipation occurred.

Unfortunately, the erratic movement and intensification of tropical cyclone 03B occurred very close to the east coast of India and brought a prolonged period of heavy rain and flooding to much of the region. At least 430 are known dead as a result of the storm. Over 20,000 people were stranded in coastal villages due to flooding.

TROPICAL CYCLONE 04B

Tropical cyclone 04B was the last tropical cyclone of 1984 to develop in the North Indian Ocean. Like two of the three storms before it, tropical cyclone 04B distinguished itself by its unusual track.

Early on 20 November a large area of convection extended from the southern Bay of Bengal across the Equator into the South Indian Ocean. There were two weak low-level circulations associated with this convection - one on either side of the equator. Although the convection showed no organization at this time, it was extensive in size; extending from 12°N to 12°S and from 70°E to 100°E. The most intense convection was near the Equator where northwest low-level flow from the northern hemisphere converged with southwest flow from the southern hemisphere.

The tropical disturbance that was to become tropical cyclone 04B first appeared as an organized area of convection within the broad area near 6°N, 85.5°E. The broad disturbance persisted during the next 5 days and by 0600 on the 25th, the two surface circulations on either side of the equator had moved further apart and were becoming more organized. Upper-level outflow over the area appeared weak but diffluent.

At 0600 on the 28th, the system had intensified with Dvorak intensity analysis indicating that surface winds of 35 kn were present. The disturbance now had a central core of intense convection.

During the next 48 hr, the storm moved in a slow anticyclonic loop while steadily intensifying. At 1200, 30 November, it had completed its loop and was estimated to have sustained surface winds of 65 kn.

Tropical cyclone 04B moved west during the next 18 hr, accelerated slightly and intensified to a peak intensity of 75 kn. It then made a slight turn to the west-northwest and made landfall on the east coast of India 40 mi north of Nagappattinam 1000, 1

December. After making landfall, the low-level circulation moved west across the southern tip of India and rapidly weakened. The mid-to-upper level circulation, however, took a more northwestward track and became displaced from the low-level center by approximately 120 mi.

The weak but persistent low-level circulation now turned to the west-southwest, entered the Arabian Sea and slowly redeveloped. By 3 December, the convection was redeveloping near the low-level center and reintensification appeared likely. Tropical cyclone 04B continued to move west-southwest, reaching an intensity of 60 kn at 0600 on the 5th. For the next 42 hr it moved in a general westerly direction across the Arabian Sea around the southern periphery of a low-to-mid-level anticyclone located near the Persian Gulf. There was no significant change in intensity during this period.

At 0600 on the 7th, tropical cyclone 04B was within 25 mi of the Somalia coast and had weakened to 35 kn. At this point, the low-level circulation, became exposed, moved inland, and then moved southwestward along the coast for 24 hr before dissipating over land.

CENTRAL NORTH PACIFIC TROPICAL CYCLONES, 1984

Mariners Weather Log

Central Pacific Hurricane Center
National Weather Service, NDAA
Honolulu, Hawaii

The Central North Pacific had three tropical depression form within the Central Pacific Hurricane Center (CPHC) area of responsibility during 1984. A tropical depression and a tropical storm moved westward across longitude 140°W from the Eastern Pacific Hurricane Center (EPHC) area of responsibility into the CPHC area. Table 8 lists the statistics for the season. Figure 25 shows the the tracks of the cyclones in the CPHC area (140°W to 180°). The complete tracks of Douglas and Keena are shown in the Eastern North Pacfic annual article on page 65 of Volume 29, No. 2 (Spring issue).

Table 8. -- Central North Pacific Tropical Cyclone Data, 1984

Cyclone Number	Names	Dates	Intensity	Maximum Winds (kn)
1	Douglas	July 3-6	TD	30
2	Keli	Aug. 16-21	HU	100
3	Kenna	Aug. 18-21	TS	50
4	Lala	Aug. 26-Sep. 2	TS	45
5	Moke	Sep. 3-5	TS	45

HU = Hurricane, TS = Tropical Storm, TD = Tropical Depression

TROPICAL DEPRESSION DOUGLAS - July 3-6

Douglas, which only a few days earlier had been a powerful hurricane over the Eastern North Pacific, entered the CPHC area of forecast responsibility on July 3 near 18°N, 140°W as a weakening tropical depression with 30-kn sustained winds. During the next several days Douglas moved along a west-northwesterly track while continuing the weakening trend. Douglas gradually slowed its forward motion to a crawl and became quasistationary near 21°N, 149°W about 500 mi east of Honolulu on July 6 when the last advisory on the dissipating depression was issued. The remnant circulation then became caught in the low-level trade flow and was carried west-southwestward to the vicinity of the big island of Hawaii and Maui on July 8 and 9. Here it helped produce some minor drought relief as 2 in rainfall amounts were common over the dry slopes of both of these island.

HURRICANE KELI - August 16-21

Hurricane Keli had its origin along the ITCZ near 9°, 150°W as tropical depression 01-C on August 16. It was named Keli as it attained tropical storm strength near 9°N, 152°W at 0000 on the 17th. It was the first tropical cyclone to develop within the CPHC area and therefore the suffix "C" and the choice of a Hawaiian name. This destinction is reserved for cyclones developing tropical storm strength between 140°W and the International Dateline. Keli moved westward at a rather low latitude between 9°N and 11°N while gaining strength and at 0000 on the 18th near 11°N, 158°W attained hurricane strength. Keli moved along a path which took it well south of the Hawaiian Islands, but it was now aiming in the general direction of the tiny atoll of Johnston Island. On approaching Johnston Island Air Force reconnaissance at 0000 on the 20th measured 100 kn maximum sustained winds near 14°N, 169°W. An upper trough was now starting to make its effect felt on Keli as the upper reaches of the circulation was being pulled northward toward Johnston Island while the trades were carrying the lower portion of the circulation westward. This shearing now started to cause a weakening of hurricane Keli.

At about 1800 on the 20th Keli made its closest approach to Johnston Island, being about 70 mi to the southwest. Lowest pressure reported at the weather station was 1009 mb at 1500 on the 20th when Keli was more directly south of the station and slightly more intense. Strongest winds reported with this relatively small-intense cyclone at Johnston while about 100 mi from the center were two gusts at 34 kn recorded between 2200 an 2400 on August 20. The installations on Johnston suffered no damage due to winds or water though the surf from southeasterly directions moving out ahead of the hurricane likely was intense. The tide recorder showed no unusually high water or surges. Rainful totaled about one inch. As a precautionary measure the Island's Military Commander had

ordered an evacuation of all personnel to Honolulu. After passing Johnston Island Keli's Low-level circulation separated out from under the upper circulation and started moving westward. Late on the 21st near 18°N, 173°W the CPHC stopped issuing advisories on the rapidly dissipating cyclone.

TROPICAL STORM KENNA - August 18-21

Tropical storm Kenna moved into the CPHC area as a weakening tropical storm at 1000 August 18 near 12°N, 140°W with an estimated 35 to 40 kn winds. Reconnaissance aircraft flying into the storm at 1800 increased this estimate to 50 kn. Kenna, however, appeared quite disorganized on the satellite pictures as it now began to slow its forward progress and drift westward along latitude 12°N on the 19th and 20th. It was downgraded to depression status and the last advisory was issued on the dissipating circulation at 0600 on the 21st when near 12°N, 148°W. The remnant circulation now moved in a more northwesterly direction toward the big island of Hawaii. Some heavy rains which were much appreciated drenched portions of the Windward and Puna districts of Hawaii where as much as 6 to 8 in were reported locally on August 22 and 23 as the weak circulation center was carried westward within the Trade flow well south of South Point.

TROPICAL STORM LALA - August 26 - September 2

Tropical storm Lala crossed 140°W into the CPHC area as a tropical depression (14-E) with 30 kn winds at 0400,26 August. It was moving westward rather slowly at 5 to 10 kn along latitude 11°N till near 11°N, 145°W on the 29th it started moving on a more northwesterly course. Air Force reconnaissance into the circulation on the 29th found winds of tropical storm strength near 45 kn and the storm was named Lala. Lala remained a minimal tropical storm for a day or so and then reverted to the tropical depression stage near 15°N, 150°W. At this point Lala commenced to move along a more westerly path which took the center about 180 mi South of South Point about 1200, Sepember 1. Effects were noticed on the Big Island with respect to increase in wind or rainfall as the weak depression moved by. The last advisor was issued at 1800 September 2 near 15°N, 165°W. The remnants of the dissipating circulation passed about 100 south of Johnston Island at 1500 on the 3d with no noticeable effects reported.

TROPICAL STORM MOKE - September 3-5

Tropical storm Moke formed near the International Dateline near 28°N on September 3. Moke developed in an area of low pressure which had been present in the that general area near Midway Island for several weeks. Initially the circulation which became tropical storm Moke was a cold core system as seen from the relatively cold temperatures aloft recorded in the Midway Island upper-air soundings. An unusual high amplitude flow pattern had persisted over the North Pacfic during much of August with strong blocking action and associated cut-off LOWS of which this particular one near Midway was one of the more dominant persistent ones.

In such a case of a cold core system gradually being transformed into a warm core tropical one through the intense latent heat releases in the convection over the warm waters, it is difficult to pinpoint the exact time of tropical storm development. The lack of adequate satellite coverage after the failure of the Eastern GOES Satellite and subsequent movement of GOES West eastward made surveillance in the area less than perfect. September 3 appears to be the time that rapid intensification occured and the first advisory by the CPHC was issued at 0000 on the 4th as the satellite pictures showed an unusually well-developed cyclone with even a hint of an eye. Several ships in the area had reported 30 to 40 kn winds and pressures down near 1000 mb over the past 24 hr along with heavy showers. At Midway Island about 90 mi to the east of the center, at the point of closest approach, late on the 3rd southerly winds gusted at 30 kn and the pressure had dropped to 1005 mb. At Kure Atoll closer to the center conditions were likely somewhat more extreme. Based on satellite Dvorak wind determinations Moke's maximum sustained winds were estimated at 45 kn at this time. Moke moved along a north-northeasterly path at 5 to 10 kn forward speed and unchanged intensity on September 4. Then on the 5th an upper trough approaching from he northwest caused shearing and rapid weaking and later on the 5th Moke was considered extratropical near 34°N, 177°W.

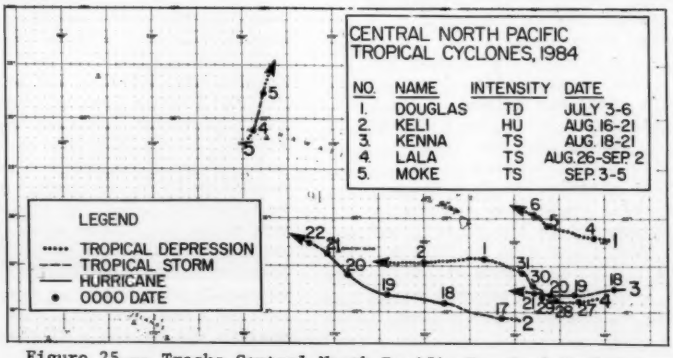


Figure 25.-- Tracks Central North Pacific Tropical Cyclones.

Marine Observations Program

Jerome W. Nickerson
National Weather Service
Silver Spring, MD 20910

GENESIS OF ATLANTIC LOWS EXPERIMENT -- GALE

Throughout United States recorded history we have all read about the terrible winter storms in the east coastal waters of the U.S. Cape Hatteras has earned the name "graveyard of ships," in a large part, due to these rapidly developing winter storms. When they swirl north of Hatteras they become the "nor'easters" of legendary New England fame. Some become monsters that fill the Atlantic from the U.S. to Europe.

How do they form: What causes them? A lot of researchers have worked at this over the years, but forecasts of the development of these storms is still not consistent. The smaller, rapidly developing systems are particularly difficult to forecast.

HOURLY OBSERVATIONS NEEDED

This year you can do something about this problem. Help by making and recording weather observations on the "Ship's Weather Observations," NOAA From 72-1A, every hour for the period of the GALE -- January 15 to March 15, 1986. The area is north of 25°N and west of 35°W. Transmit only the normal synoptic observations, but record all hourly observations on the NOAA Form 72-1A. Mail the form to your servicing PMO as you now do routinely at the end of each month. You should have preaddressed, postage-paid envelopes for this. If you don't have the envelopes or can't remember the PMO's name, write me a note and I'll get some envelopes mailed to you from the correct PMO.

SHIPS NOT IN THE U.S. VOLUNTARY OBSERVING SHIP PROGRAM

This magazine is distributed worldwide, so we invite other VOS program managers to distribute the information on GALE and urge their program ships to participate. They may also write to me, or any PMO, using the addresses in the back of this magazine and we will send forms, pens to fill them out, and preaddressed, postage-paid (U.S. mail only) envelopes.

If all the ships that travel through the GALE area make and record weather observations, we should have an excellent data base. The research to be done on this experiment should improve marine weather forecasting generally as some parts should be applicable almost everywhere. We view this experiment as an opportunity for the mariner to participate in something very important to marine interests and improved oceanic weather forecasts.

ENTERING DATA INTO THE "SHIP'S WEATHER OBSERVATIONS," NOAA FORM 72-1A

There is an example of a completed 72-1A inside the front cover of the form booklet, part of which is copied in figure 26. It covers most situations that an observer may encounter. Each page of the form must have a complete heading, because the forms may become separated during the data-recording processes. As a minimum, each sheet must have the ship's name, call sign, month and year in the heading.

Some places where mistakes occur:
Time of Observation, GG -- The small preprinted numbers are reminders of the synoptic hour. Please cross out the number and enter the correct hour.
Weather Data Indicator, i_x -- Enter 1 if the weather group, $7wwW_1W_2$, is entered and 2 if it is omitted. Cloud height, h, enter a solidus of slash, "/, "if N=0 or 9 and the 8 group, clouds is omitted.

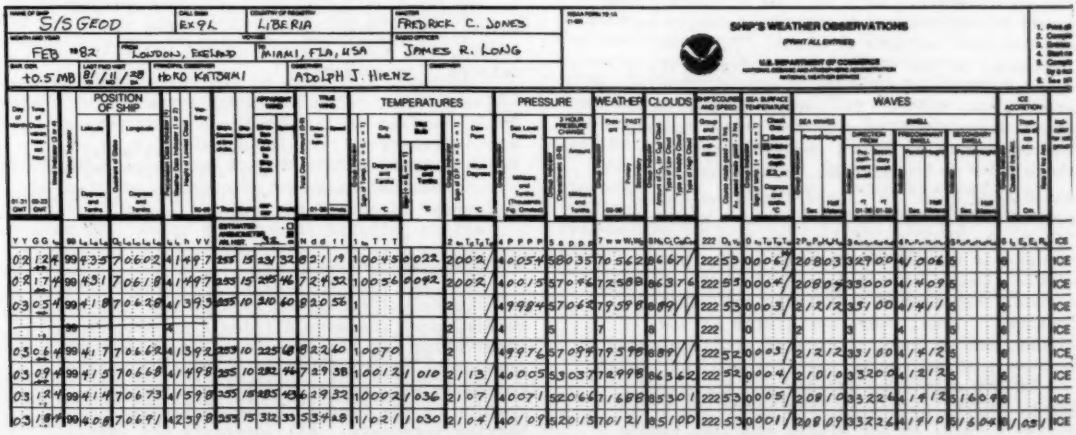


Figure 26.-- Completed "SHIP'S WEATHER OBSERVATIONS," NOAA FORM 72-1A.

Ship Course and Speed and Apparent Wind -- The four columns under these headings are shaded, which means they should not be transmitted. There is also no need to fill in these columns unless the ship has an anemometer. If the ship has an anemometer, these data may be entered as a notebook to help in calculating the true wind.

Total Cloud Amount, N -- The number in this column should support the data given in the cloud group, $8N_hC_LC_MC_H$. If N=0 or 9, the 8 group is omitted.

Nddff -- All of the blanks to the left of, and including, this group must be completed to make the computers function properly. All of the groups to the right have group indicators and may be completely omitted without affecting the operation of the computer in handling the data. Notice that all of the temperatures in the third row have been omitted.

Wet Bulb -- The wet bulb temperature is a shaded column, or a notebook column. The data is not transmitted.

Dew Point, $2S_nTdTdTd$ -- The preprinted solidus or slash, "/, will be removed from future forms as mentioned below.

3-Hour Pressure Change, 5appp -- A trace of a barograph (barogram) is often used for these entries; however, if the pressure is recorded hourly it will provide reasonable data for this group.

Weather, $7wwW_1W_2$ -- The last paragraphs of pages 2-77 and 2-93 of the National Weather Service Observing Handbook No. 1 state that ww codes 00, 01, 02, and 03, and W_1W_2 codes 0, 1, and 2 are weather without significance. If both ww and W_1W_2 are weather without significance, the weather group should be omitted and i_x entered as 2. The weather in the last row is of this category. Note that i_x is recorded as 2 and the group was not transmitted. The whole 7 group could be omitted.

Clouds, $8N_hC_LC_MC_H$ -- This group probably creates the most confusion of any frequently reported group. It is used in conjunction with the total cloud amount, N in the group Nddff. If N is 0 or 9, the 8 cloud group is omitted and h for cloud height is entered as a solidus or slash, "/." For instance, in the first line of figure 26, N = 8, or 8 oktas, completely overcast. The cloud group shows 8667/. The second column, N_h=6 means there are 6/8ths of low cloud because the low cloud, C_L has a number in it. If there were no low clouds, this column, C_L, would have a "0" in it and the cloud amount would refer to the middle clouds. With the "/" in the high clouds, C_H, it means that the sky is completely covered by low and middle clouds (obscured) and if there are high clouds, they cannot be seen by the surface observer. Thus, there are 6/8ths of low clouds, and at least 2/8ths of middle clouds because nothing can be seen through that level.

In the next row, N=7/8th and the cloud group, 86376, indicates that there are 6/8th of low clouds, so the middle and high clouds only account for an additional 1/8th with 1/8th of the sky being clear, i.e., 6/8 C_L + 1/8 C_M and C_H = 7/8th total cloud amount. The third and fifth row, 889//, indicates that the sky is overcast, 8/8ths, by low clouds, and no middle or high clouds can be observed.

In the seventh row, there are 5/8ths of low clouds, no middle, and 1/8h high clouds. In the last row, the 5/8ths cloud amount is all low clouds and no middle or high clouds.

Group and Section Indicator, 222 -- This indicator, 222--, must be used before any group at the right, as it resets the computer to properly recognize and use the following groups.

Sea Surface Temperature, $0s_nT_wT_wT_w$ -- In this instance, the "/" means that the thermometer is not accurate enough to read to the tenth of a degree.

Sea Waves, $2P_wP_wH_wH_w$ -- These are the waves raised by the wind and actually ride up and over swell because the wind or sea waves usually travel slower than swell. This is one way of separating sea waves and swell. However, in a storm the two types of waves will almost always be found together and may be difficult, if not impossible, to separate.

If the ocean is calm, i.e., no sea waves or swell, the 2 group should be reported as 20000 and the swell groups 3, 4, and 5 are omitted. If there are no sea waves, but there are swell, the 2 group may be omitted or entered as 20000.

Swell, $3d_{w1}d_{w1}d_{w2}d_{w2}$ $4P_{w1}P_{w1}H_{w1}H_{w1}$ $5P_{w2}P_{w2}H_{w2}H_{w2}$ -- Swell are the very long crested waves that are quite regular in wave height, length, and speed. They generally come from some other area and may pass by your ship without any local wind, or from a different direction that the local wind.

There are provisions for entering two swell wave records; however, it is not the usual situation to have two swell trains that are significant. If there is no distinct and significant secondary swell the 5 group should be omitted and the direction $d_{w2}d_{w2}$ in 3 group entered as 00, i.e., $3d_{w1}d_{w1}00$.

If there is no swell, but there are sea waves, the 3 group should be entered as 30000. The 4 and 5 swell groups would be omitted. In summary:

SEA	SWELL	PRIMARY
No	No	20000
No	Primary	$3d_{w1}d_{w1}00$ $4P_{w1}P_{w1}H_{w1}H_{w1}$
Yes	Primary & Secondary	$2P_wP_wH_wH_w$ $3dw_1dw_2dw_2$ $4P_{w1}P_{w1}H_{w1}H_{w1}$ $5P_{w2}P_{w2}H_{w2}H_{w2}$
Yes	No	$2\ P_wP_wH_wH_w$ 30000

Coastal Observations

With the continuation of ship automation and the reduction in the size of the crew it becomes more and more difficult to make an observation and transmit it. This task must somehow be accomplished or the ship's weather forecasts will suffer whether you use ship routing or the general National Weather Service forecasts. All forecasts are based

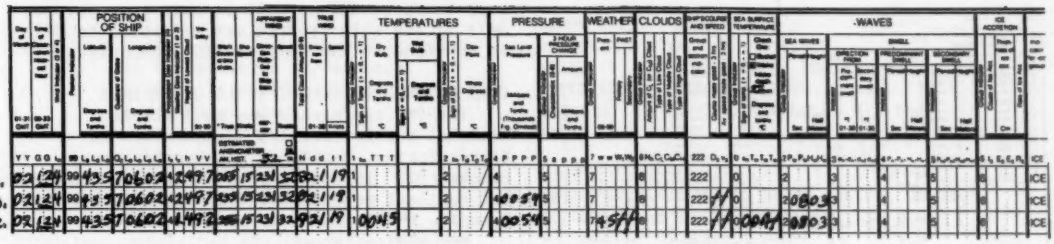


Figure 27.-- Abbreviated forms of weather observations.

upon ship observations.

As it says in the National Weather Service Observing Handbook No. 1 only the first five groups (without identifiers) of a weather report are mandatory. All of the other groups to the right of Nddff may therefore be omitted, if there is no weather of significance to report, there isn't time for a full report, or other duties prevent a full report.

For example, the first observation from figure 27 is presented in three different ways. In observation A, only the mandatory groups are logged. However, this doesn't give much weather information. Notice the "Weather Data Indicator" is 2, indicating that the weather group is omitted.

In observation B, the bare essentials of pressure and sea waves are added. Notice that the "Group and Section Indicator," 222 must be used because the sea waves group is to the right of the 222. The small horizontal bar in the solidus or slash, 222, helps to prevent confusing the slash with number 1.

In observation C, the weather group has been added because fog is now present and that is very significant. The "Weather Data Indicator" is changed to 1 and the visibility is, of course, changed because of the fog. "Air Temperature" and "Sea Surface Temperature" are also added because these are important information in a weather report with fog.

Assuming that the watch officer has the minimum time to devote to making a weather observation and cannot leave the bridge for any period of time, this shows how the weather observation may be reduced. Naturally, these are not as good as a full observation, but the reduced observation may be used if you cannot make a full observation. The point is -- make some observation and transmit it promptly.

PROPELLER CLUB OF THE UNITED STATES

I had the opportunity to speak before the Propeller Club of the U.S. in Savannah, GA on October 17. After the general briefing on the U.S. Voluntary Observing Ship Program I called for them to consider environmental instruments as part of the ship's basic equipment when the specificatons for new ships, or modernization are drawn up. Anemometers, air and sea water temperature instruments, at least, should be part of all new ship designs. The pay back in ship safety and increased fuel economy by using these instruments is usually evident from the first voyage.

Figure 28 shows a spectacular satellite view of the Gulf Stream during a break in the clouds, to the right and to the upper left. Cape Code can be seen in the upper center. The Gulf stream is the dark, meandering streak through the center of the photo. Colder waters to the north are vividly portrayed. A good sea surface temperature readout on the bridge would allow ships to save fuel by keeping in the Stream going northeast and avoiding it going in the opposite direction.

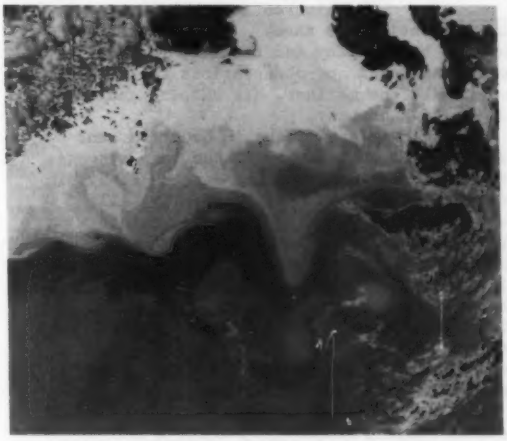


Figure 28.-- Satellite image of the Gulf Stream.

A marine package is broadcast daily from 4-6 a.m. local time on NOAA WEATHER RADIO. Included in this broadcast is a description of the oceanography of the West Central North Atlantic between 35°N and 40°N and west of 70°W. This broadcast is updated on Tuesday, Thursday, and Saturdays. The radio frequencies are 162.4 MHz in Baltimore, MD, and 162.55 MHZ in Norfolk, VA.

The Gulf Stream Wall Bulletin is a voice broadcast over Coast Guard radio Portsmouth (NMN) at 1600Z and 2200Z on Single Side Band frequencies 6506.4, 8765.4, and 13113.2 kilohertz. It is updated on Mondays, Wesnesdays, and Fridays.

Facsimile maps like that shown in figure 29 are also available.

SHIP ROUTING COMPANIES AND NWS

In any gathering of marine people, company executives, or ship officers, the comments babout observations are almost predictable. Among them will almost always be the

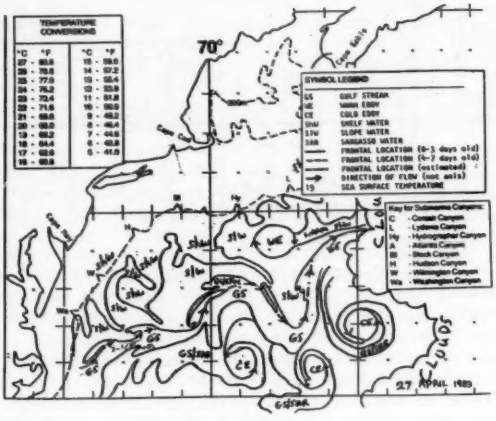


Figure 29.-- Example of Gulf Stream facsimile chart.

statement, "We get our weather forecasts from _____ ship routing company and send our observations to them." That cheats the mariner, his company and the ship routing company and send our observations to them." That cheats the mariner, his company and the ship routing company.

If the ship's officers in question sent their weather observation in the ship synoptic code to the National Weather Service (NWS), in addition to the ship routing company, all would be served better. All ship weather reports addressed to NWS (see Tips for the Radio Officer) go through the computers at the National Meteorological Center (NMC) where the data is analyzed and made into support and guidance products. These products and all the ship reports received at NMC are made available to the ship routing companies so they can made detailed forecasts.

If you send your weather report only to the ship routing company, it doesn't get to NMC nor become a part of the guidance products. It only does part of the job it could do. NWS loses, so does the ship routing company, and so do you. NWS works with your ship routing companies to supply them with computer products as well as ship reports, but only if the ship reports are addressed to NWS in addition to the ship routing companies.

PORT METEOROLOGICAL OFFICERS CONFERENCE

The PMO conference was held at the National Weather Service Headquarters in Silver Spring, Maryland, October 28 through October 31. In addition to the 13 U.S. PMO's and regional representatives, there were 4 Canadian PMO's and their program leader.

Mr. Howard Israel, the radio/electronics officer of the AMERICAN ALABAMA was on leave from his ship and participated in the conference. His comments were greatly appreciated.

We had experts from the National Climatic Data Center, the Washington Forecast Office, the National Meteorological Center, the National Ocean Service, and the Office of Technical Services Engineering and Communications Divisions from NOAA. Other speakers were from the U.S. Coast Guard and the Defense Mapping Agency.

The purpose of these conferences is to exchange experiences, standardize procedures, and develop ways to improve the program. As I have said many times before, comments from the ship's officers about the program are always welcome. Many of the subjects in this article are in response to letters from ship officers.

NEW DEW POINT TABLES

A new dew point table has been developed that requires no computation. You enter the table with the dry-bulb and wet-bulb temperature readings and read the dew-point directly from the table. The table also gives relative humidity which should assist in cargo management as well as weather applications.

MARINE OBSERVATIONS PROGRAM LEADER TO RETIRE

February 3, 1986 will be my last working day as Marine Observations Program Leader. I plan to remain in the local area and do consultant work and catch up on a lot of writing. Until a new program leader is hired and has a chance to get organized, I will continue the Marine Observation Program feature in the Mariners Weather Log.

Tips to the Radio Officer

Julie L. Houston
National Weather Service, NOAA
Silver Spring, MD

CORRECTIONS TO SELECTED WORLDWIDE MARINE WEATHER BROADCASTS (January 1985 Edition)

NOTE: Schedule changes that will affect "Selected Worldwide Marine Weather Broadcasts" publication should be sent to the following address:

ATTN: W/OTS32 - Julie L. Houston
National Weather Service
Gramax Bldg., - Rm. 419
8060 13th Street
Silver Spring, MD 20910

Please include your telephone number and a contact person.

Page 1

Add: THE FOLLOWING PAR. UNDER PAR. 3: Sales to the public are available from Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20302. The price of the publication is $7.50. Please refer to stock number 003-017-00522-4 when ordering.

Page 2
Change: Radiofacsimile and Radiotelegraph in Organization of Handbook Section to Radiofacsimile and Radioteleprinter.

Page 71
Change: 432 to 431 in GKR, Wick, Scotland

Page 72
Change: 432 to 431 in GKR, Wick, Scotland

Page 73
Change: 432 to 431 in GKR, Wick, Scotland

Page 86 and 87
Interchange page 86 to 87

Page 122
DELETE:
TIME: 0130, 0730, 1330 and 1930
PRODUCT: W,F
AREA: Northwest Pacific; Ocean area Equator
FREQUENCY: 13113.2 and 6506.4 (A3J)
SOURCE: NRV, Guam, Marianas Island

Page 146
Add: EXP-Experimental to Explanatory Notes Number 4

Page 147
ADD WLO Mobile, Alabama to North Atlantic West, United States of America Section.

Page 149
ADD JMJ, TOKYO to North Pacific West, Japan Section.

New Zealand
ZKLF Auckland to South Pacific Ocean Section.

Page 151
ADD: 22. Full Disc infra-red imagery from GOES-W satellite.

23. Experimental products when available and broadcast four consecutive days: Ocean Color or frontal analysis and 15-day mean sea surface temperature analysis.

Page 152
0530 NMF, Boston, Mass USA
Change: Frequency from 3242.5 to 3242

Page 173
DELETE: All Entries for KVM70, HONOLULU, HI, USA
Enire entry for 0054 WWD,LA JOLLA, CA, USA

ADD:
TIME: 0001
AREA: 40°N, 25°S; 110°W, 160°E.
FREQUENCY: 9982.5, 11090, 16135, 23331.5
SOURCE: KVM70, HONOLULU, HI, USA
NOTE: 21

TIME: 0015
PRODUCT: A
AREA: 40°N, 25°S, 110°W, 160°E
FREQUENCY: 9982.5, 11090, 16135, 23331.5
SOURCE: KVM70, HONOLULU, HI, USA
NOTE: 21

TIME: 0030
FREQUENCY: 9982.5, 11090, 16135, 23331.5
SOURCE: KVM70, HONOLULU, HI, USA
NOTE: 22

TIME: 0046
PRODUCT: N
AREA: 40°N, 25°S, 110°W, 160°E.
FREQUENCY: 9982.5, 11090, 16135, 23331.5
SOURCE: KVM70, HONOLULU, HI, USA
NOTE: 21

TIME: 0100
PRODUCT: WP
AREA: 40°N, Equator; 110°W, 160°E.
FREQUENCY: 9982.5, 11090, 16135, 23331.5
SOURCE: KVM70, HONOLULU, HI, USA
NOTE: 21

Page: 174
DELETE: All Entries for KVM70, HONOLULU, HI, USA

ADD: 0540
PRODUCT: T
FREQUENCY: 9982.5, 11090, 16135, 23331.5
SOURCE: KVM70, HONOLULU, HI, USA
NOTE: 21

TIME: 0547
AREA: 30°N, 50°S; 90°W, 180°E.
FREQUENCY: 9982.5, 11090, 16135, 23331.5
SOURCE: VRM70, HONOLULU, HI, USA
NOTE: 21

TIME: 0601
AREA: 40°N, 25°S; 110°W. 160°E.
FREQUENCY: 9982.5, 11090, 16135, 23331.5
SOURCE: KVM70, HONOLULU, HI, USA
NOTE: 21

TIME: 0615
PRODUCT: A
AREA: 40°N, 25°S; 110°W. 160°E.
FREQUENCY: 9982.5, 11090, 16135, 23331.5
SOURCE: KVM70, HONOLULU, HI, USA
NOTE: 21

TIME: 0630
FREQUENCY: 9982.5, 11090, 16135, 23331.5
SOURCE: KVM70, HONOLULU, HI, USA
NOTE: 22

TIME: 0646
PRODUCT: N
AREA: 40°N, 25°S, 110°W, 160°E.
FREQUENCY: 9982.5, 11090, 16135, 23331.5
SOURCE: KVM70, HONOLULU, HI, USA
NOTE: 21

TIME: 1105
PRODUCT: T

FREQUENCY: 9982.5, 11090, 16135, 23331.5
SOURCE: KVM70, HONOLULU, HI, USA
NOTE: 21

TIME: 1117
AREA: 30°N, 50°S, 90°W, 180°.
FREQUENCY: 9982.5, 11090, 16135, 23331.5
SOURCE: KVM70, HONOLULU, HI, USA
NOTE: 21

TIME: 1131
PRODUCT: A
AREA: 40°N, 25°S, 110°W, 160°E.
FREQUENCY: 9982.5, 11090, 16135, 23331.5
SOURCE: KVM70, HONOLULU, HI, USA
NOTE: 21

TIME: 1145
AREA: 40°N, 25°S, 110°W, 160°E.
FREQUENCY: 9982.5, 11090, 16135, 23331.5
SOURCE: KVM70, HONOLULU, HI, USA
NOTE: 21

TIME: 1200
FREQUENCY: 9982.5, 11090, 16135, 23331.5
SOURCE: KVM70, HONOLULU, HI, USA
NOTE: 22

TIME: 1216
PRODUCT: N
AREA: 40°N, 25°S; 110°W, 160°E.
FREQUENCY: 9982.5, 11090, 16135, 23331.5
SOURCE: KVM70, HONOLULU, HI, USA
NOTE: 21

TIME: 1230
AREA: 40°N, Equador; 110°W, 160°E.
FREQUENCY: 9982.5, 11090, 16135, 23331.5
SOURCE: KVM70, HONOLULU, HI, USA
NOTE: 21

Page: 176
DELETE: All Entries for KVM70, HONOLULU, HI, USA

1700 WWD, LA JOLLA, CH, USA
REPLACE Area SECTION and PRODUCT Section with the following:
AREA: 20°S-30°N, East of 160°W.
PRODUCT: A

ADD:
TIME: 1755
PRODUCT: T
FREQUENCY: 9982.5, 11090, 16135, 23331.5
SOURCE: KVM70, HONOLULU, HI, USA
NOTE: 21

TIME: 1802
AREA: 30°N, 50°S; 90°W, 180°.
FREQUENCY: 9982.5, 11090, 16135, 23331.5
SOURCE: KVM70, HONOLULU, HI, USA
NOTE: 21

TIME: 1816
PRODUCT: A
AREA: 40°N, 25°S; 110°W, 160°E.
FREQUENCY: 9982.5, 11090, 16135, 23331.5
SOURCE: KVM70, HONOLULU, HI, USA
NOTE: 21

TIME: 1830
FREQUENCY: 9982.5, 11090, 16135, 23331.5
SOURCE: KVM70, HONOLULU, HI, USA
NOTE: 22

TIME: 1846
PRODUCT: A
AREA: 60°N, 10°S; 115°W, 155°E.
FREQUENCY: 9982.5, 11090, 16135, 23331.5
SOURCE: KVM70, HONOLULU, HI, USA
NOTE: 21

TIME: 1903
PRODUCT: N
AREA: 40°N, 25°S; 110°W, 160°E.
FREQUENCY: 9982.5, 11090, 16135, 23331.5
SOURCE: KVM70, HONOLULU, HI, USA
NOTE: 21

TIME: 1917
PRODUCT: SST
AREA: 60°N, 34°S; 110°W, 98°E.
FREQUENCY: 9982.5, 11090, 16135, 23331.5
SOURCE: KVM70, HONOLULU, HI, USA
NOTE: 21

Page: 178
DELETE: All Entries for KVM70, HONOLULU, HI, USA

2300 WWD, LA JOLLA, CA, USA
REPLACE: AREA Section and PRODUCT Section with the following:
AREA: 20°S-30°N, East of 160°W
PRODUCT: A

DELETE: Entire entries for 2312, 2330, 2342, and 2354
AREA: WWD, LA JOLLA, CA, USA

ADD:
TIME: 2335
PRODUCT: T
FREQUENCY: 9982.5, 11090, 16135, 23331.5
SOURCE: KVM70, HONOLULU, HI, USA
NOTE: 21

TIME: 2347
PRODUCT: K
FREQUENCY: 9982.5, 11090, 16135, 23331.5
SOURCE: KVM70, HONOLULU, HI, USA
NOTE: 21

TIME: 2347
AREA: 30°N, 50°S, 90°W, 180°.
FREQUENCY: 9982.5, 11090, 16135, 23331.5
SOURCE: KVM70, HONOLULU, HI, USA
NOTE: 21

MAJOR MARINE WEATHER RADIO FACSIMILE SCHEDULES, PACIFIC OCEAN

A new edition of Major Marine Weather Radiofacimile Schedules for the Pacfic Ocean dated October 1985 has been published.

Information on obtaining the booklet may be obtained from the:

Northwest Ocean Service Center
7600 Sand Point Way NE BIN CI5700
Seattle, WA 98115
Phone (206)526-NOAA

NAVY NORFORLK FACSIMILE SCHEDULE
NAVAL EASTERN OCEANOGRAPHY CENTER
NORFOLK, VIRGINIA
REVISED NFAX BROADCAST SCHEDULE
EFFECTIVE 01 AUG 85

TOT (Z)	TRANSMISSION CONTENT	V.T.
0000/1200	500MB HT/TEMP/WIND 24HR PROG	12/00
0015/1215	400MB HT/TEMP/WIND 24HR PROG	12/00
0030/1230	300MB HT/TEMP/WIND 24HR PROG	12/00
0045/1245	200MB HT/TEMP/WIND 24HR PROG	12/00
0100/1300	GOES SATELLITE PICTURE	
0115	NMC EXTENDED SFC/UA PROG	
1315	NMC 200MB TROP ANAL	/00
0135	SST GOLF STREAM ANAL FULL (TUE/SAT)	
	TSGS (SUN/THURS)	
	NFAX SCHEDULE (MON, WED, FRI)	
1335	SST GULF STREAM ANAL I (MON)	
	FLD (TUES/FRI)	
	OPEN PERIOD (SED/THURS/SAT/SUN)	
0150	TSNS (MON/FRI)	
	TSIB (TUES/SAT)	
	OPEN PERIOD (SUN/WED/THURS)	
1350	SEA TEMP ANAL (MON/THURS)	
	TSNF (TUES/SAT)	
	NMC TROP SFC ANAL (SUN/WED/FRI)	/00
0205/1405	500MB HT/TEMP/WIND 48HR PROG	12/00
0220/1420	FREEZING LVL 24HR PROG	12/00
0235/1435	NMC RADAR SUMMARY	
0245/1445	GOES SATELLITE PICTURE	
0300/1500	NMC SIG WX 12HR PROG (SFC-400MB)	
0320/1510	NEOC 36HR PROG BLEND	00/12
0325/1525	OPEN PERIOD	
0335/1535	NMC 24HR 500MB HT CHANGE	00/12
0350/1550	NEOC NEPHANALYSIS	
0410/1601	NMC RADAR SUMMARY	
0420/1620	NEOC NLANT SFC PRES ANAL	00/12
0435/1635	NMC LFM 24 HR PROG	00/12
0450/1650	OPEN PERIOD	
0500/1700	DMSP SATELLITE PICTURE	
0515/1715	SFC TROP ANAL	
0530/1730	BRACKNELL 24HR SFC PROG	00/12
0545/1745	GOES SATELLITE PICTURE	
0600/1800	NMC LFM 48HR PROG	00/12
0615	NMC RADAR SUMMARY	00/12
0620	OPEN PERIOD	
1815	NEOC SEA HEIGHT ANAL	/12
0635/1853	850MB HT/TEMP/WIND ANAL	00/12
0650/1850	700MB HT/TEMP/WIND ANAL	00/12
0705/1905	500MB HT/TEMP/WIND ANAL	00/12
0720/1920	300MB HT/TEMP/WIND ANAL	00/12
0735/1935	NMC RADAR SUMMARY	
0740/1940	SFC PRES/WIND 12HR PROG	00/12
0755/1955	SFC PRES/WIND 24 HR PROG	00/12
0810/2010	OPEN PERIOD	
0820/2020	NMC 24HR SIG WX	00/12
0820/2030	NMC 36/48HR SIG WX	
0840/2040	NMC RADAR SUMMARY	
0845/2045	DMSP SATELLITE PICTURE	
0900/2100	NMC ANAL TROP OCEAN LWR LYR	00/12
0915/2115	OPEN PERIOD	00/12
0925/2155	SFC PRES/WIND 48HR PROG	00/12
0940/2140	SFC PRES/WIND PRELIM	06/18
0955/2155	GOES SATELLITE PICTURE	00/12
1010/2210	SIG WAVE HT 24HR PROG	00/12
1025/2225	850MB HT/TEMP/WIND 36HR PROG	12/00
1040/2240	500MB HT/TEMP/WIND 36HR PROG	12/00
1055/2255	NMC 36HR 500MB HT/ISOTACH PROG	
2305	BRACKNELL 48HR SIG WAVE PROG	/12
1115/2315	DMSP SATELLITE PICTURE	/12
1130/2330	850MB HT/TEMP/WIND 24HR PROG	00/12
1145/2345	700MB HT/TEMP/WIND 24HR PROG	00/12

FREQS	TIMES	FREQS	TIMES
8080, 10865	CONTINUOUSLY	16410	1200Z-0000Z
3357	0000Z-1800Z	20015	1800Z-0000Z

TIPS FOR THE RADIO OFFICER
Jerome W. Nickerson

Radio/Electronics Officer Participates in PMO Conference

Howard Israel, the radio/electronics officer on the M/V AMERICAN ALABAMA, on leave from the ship, attended the Port Meteorological Officer Conference at National Weather Service Headquarters October 29-31, 1985. Communications plays a major role in marine observations and forecasting programs, so Mr. Israel's participation helped in clarifying several areas of shipboard operations.

INMARSAT Charges

There has been a report of a company being charged for a ship weather report that was sent in by INMARSAT. Officials at COMSAT, the U.S. INMARSAT representative, say that no ship or company following our stated procedures should be charged for weather reports. However, if such a thing occurs, the company should return the invoice to COMSAT for adjustment.

We have not identified the specific circumstances; however, there are a few possibilities:

- Only the United States, Great Britain, France, and Singapore have programs to pay for ship weather reports. Sending a weather message to other countries may result in a charge to the company.
- The weather message may have been sent as a continuation of another message that normally requires a charge. Weather messages should be sent as an individual message.
- Or, it could have been a clerical goof. In any case, COMSAT is willing to work with you and NWS on any billing problems.

INMARSAT Weather Reports

The correct procedure to send a ship weather report is as follows:

1. Select U.S. Coast Earth Station identification code 01.
2. Select routine priority.
3. Select duplex telex channel.
4. Initiate the call.
5. Upon receipt of GA+ (Go Ahead), select Code 41+.
6. The response will be our answerback, NWS OBS MHTS, which will appear on your screen.
7. Send your call and weather message. End the message with 5 periods.

You should NOT have any preamble, your answerback number, or your ship's name after the GA+. Your screen or message copy should look like this:

```
GA+
41+
NWS OBS MHTS
WLXX 29003 99131 70808 42998 60909
22234 20201 30000 .....
```

The GA+ and NWS OBS MHTS are answerbacks, the rest you add.

Charges for the INMARSAT (and radio) ship weather reports are made automatically to the U.S. National Weather Service. No other action is required by either the ship or the company.

Ship Weather Reports to U.S. Coast Guard Radio Stations

Usually, a ship will inform the Coast Guard radio station that the ship has a weather message on the initial call-up. With the U.S. Coast Guard, there is only one place

they send weather messages, so no address or preamble is needed. When you are cleared to send your message, send your call sign and then the numbers of the weather report -- no address or preamble.

Ship Weather Reports to U.S. Commercial and Foreign Radio Stations.

These weather reports require an address. In the U.S., it is OBS METEO WASHDC. The next edition of "Stations Accepting Ship's Weather and Oceanographic Reports" will have worldwide addresses of radio and satellite communications stations. Commercial radio messages, in addition to having an address, should be sent in 10-character groups following the call sign of the ship. Example:

OBS METEO WASHDC
WLXX 2518399040 7006942398 4230810260, etc.

Reporting Areas

Weather reports will be accepted without charge to the ships or companies from the following forecast and warning areas:

Pacific: 160°E eastward to the coast and north of 25°S.
Atlantic: 35°W westward to the coast and north of 3°N.
Guam: Between 5°N and 25°N and from 135°E to 180°.
INMARSAT only: South of 60°S.

Completed Message Forms

REO's are requested to send the completed message forms, with comments added, if appropriate, back to the bridge. These forms should be included in the envelope with the "Ship's Weather Observations" record forms for mailing to the servicing PMO. The PMOs will send them back to this office where we act on any comments the PMO's haven't already taken care of and use the message data in various studies.

Incidentally, the top few 72-4A's on my desk show groups that are all solidi or slashes, i.e., 7////, 8////, 5////, 6////. Those were all in one message. Pleast don't send empty groups or groups with no information. Any group with a number identifier may be omitted if there is nothing to report.

Weather Message Cut-Off Times

All of our weather maps are plotted by computer-controlled machines, so the analysts and forecasters get to see the weather map in the shortest possible time. From these maps, they must make the decisions on the forecast and get it out to the radio stations as quickly as possible, so you people at sea will have the forecast in a reasonable time after you send in your weather messages.

The cut-off times, or the time when the computer will accept no more data and starts working on a program, are:

Computer Cut-Off Times After the Synoptic Hour

Hour:minutes		Map
:20	North American Surface	(preliminary)
:40	North American Surface	(final)
1:20	Northern Hemisphere Surface	(preliminary)
1:40	Northern Hemisphere Surface	(facsimile)
4:20	Northern Hemisphere Surface	(final)

The North American Surface weather map is analyzed every 3 hours and includes a lot of ocean area, particularly the Gulf of Mexico. Not many ships appear on these maps at present, but those that do are really important in the analysis.

The Northern Hemisphere analysis that has a cut-off at 1:40 is used for the facsimile maps and the marine forecast. The final Northern Hemisphere cut off at 4:20 is used as a preliminary "first-guess" map for the upcoming synoptic hour. As you can see, early arrival assures the maximum usage of your messages.

The Editor's Desk

INITIAL C-MAN STATIONS NEAR COMPLETION

NDBC started preparatory work on the C-MAN program in fiscal year 1979 by adapting its General Service Buoy Payload to the RFI and EMI environment of the U.S. Coast Guard's Large Navigational Buoy (LNB). This system has been deployed on the Columbia River, Oregon, LNB since November 1979. Similar installations were made in 1982 on the LNBs at Portland, Maine, San Francisco, California, and Nantucket, Massachusetts.

Concurrently, NDBC was developing the Data Acquisition Control and Telemetry (DACT) system for C-MAN stations. This development and prototyping of two fixed stations and one LNB lasted from September 1981 until September 1983, when implementation of the operational stations was begun. From September 1983 through December 1984, new DACT installations were made at 32 fixed sites and on 3 LNBs. In addition, the two prototype fixed stations and two LNBs were upgraded to a production DACT configuration. The initial network of 41 fixed stations, 9 LNBs, and 6 retrofitted DARDC/RAMOS stations is scheduled for completion by the end of 1985 (table 9.)

Some expansion parameters have been installed as selected stations whenever resources and schedules allowed. Waves measured by a wavestaff have been delivered from Chesapeake Light Station, Virgina, since August 1984. Future wavestaff installions are tentatively planned for Light Stations (L.S.) at Ambrose, New York, Diamond Shoals, North Carolina, Frying Pan Shoals, North Carolina, Buzzards Bay, Massachusetts, Savannah, Georgia, and the pier at Lake Worth, Florida. Sea surface temperature sensors were installed at Lake Worth, Florida, Ambrose L.S., New York, Cheaspeake L.S., Virginia, Frying Pan

Shoals L.S., North Carolina, and Diamond Shoals L.S., North Carolina.

Data have been reported from a U.S. Geological Survey rain gauge at the Sabine, Texas, station since July 1984. An NWS tipping bucket rain gauge was installed at Point Arena, California, in October 1984. Rain guages are presently planned for Cheaspeake L.S., Ambrose L.S., and Savannah L.S.

The Tides Branch of NOS and NDBC have worked closely to install a Leupold-Stevens tide gauge and a C-MAN station at Lake Worth, Florida. The tide reading at the top of the hour has been reported by the DACT since July 1984. A similar installation was installed at Grand Isle, Louisiana, in March 1985.

Table 9.-- C-MAN sites

Station	Station ID	Install Date
Portland, ME-LNB	44007	1/82
Boston, MA-LNB	44013	8/84
Nantucket, MA-LNB	44008	8/82
Five Fathoms, NJ-LNB	44021	6/84
Delaware Bay, DE-LNB	44009	1/84
San Francisco, CA-LNB	46026	7/82
Blunts Reef, CA-Buoy	46030	10/84
St. George Reef, CA-LNB	46027	4/83
Columbia River, OR-LNB	46010	11/79
Passage Island, MI	PILM4	5/84
Rock of Ages, MI	ROAM4	10/83
Devil Island, WI	DISW3	10/83
Stannard Rock, MI	STDM4	7/84
Sheboygan, WI	SGNW3	10/83
Isle of Shoals, NH	IOSN3	9/84
Buzzards Bay, RI	BUZM3	19/85
Ambrose L.S., NY	ALSN6	11/84
Cape Lookout, NC	CLKN7	11/84
Galloo Island, NY	GLLN6	9/83
Dunkirk, NY	DBLN6	3/83
South Bass Island, OH	SBIO1	9/83
Matinicus Isle, ME	MISM1	9/84
Folly Island, SC	FBIS1	5/84
St. Johns Light, FL	SJLF1	5/84
Lake Worth, FL	LKWF1	7/84
Alligator Reef, FL	ALRF1	12/84
Venice, FL	VENF1	19/85
Cape San Blas, FL	CSBF1	5/84
Southwest Pass Light, LA	BURL1	2/84
Sabine, TX	SRST2	2/84
Port Aransas, TX	PTAT2	3/84
Point Arguello, CA	PTGC1	4/84
Cape Arago, OR	CARO3	8/84
Newport, OR	NWPO3	4/84
West Point, WA	WPOW1	1/84
Point Arena, CA	PTAC1	10/84
Smith Island, WA	SISW1	1/84
Destruction Island, WA	DESW1	8/84
Tatoosh Island, WA	TTIN1	8/84
Five Finger Island, AK	FFIA2	7/84
Existing stations to be Upgraded		
Mount Desert Rock Light,	ME MDRM1	8/84
Chesapeake Light, VA	CHLV2	8/84
Diamond Shoals Light, VA	DSLN7	11/84
Frying Pan Shoals Light,	NC FPSN7	11/84
Grand Isle, LA	GDIL1	12/84
Savannah Light, GA	SVLS1	5/85

Since our last update, Grand Isle, Louisiana, and Savannah L.S., Georgia, were substituted for the Salt Point, Louisiana, and Tenneco Oil Platform, Louisiana, sites. The table gives the existing sites, station IDs, and installation dates.

From National Data Buoy Center Technical Bulletin by R.H. Canada, Jr.

U.S. AND JAPAN BEGIN EXCHANGE OF SEARCH AND RESCUE INFORMATION

The United States Coast Guard and the Japanese Maritime Safety Agency began exchanging search and rescue information on October 1, 1985. The exchange between the Automated Mutual-Assistance Vessel Rescue System (AMVER) and the new Japanese Reporting System (JASREP) signifies the beginning of a new era in maritime safety.

As a service to voluntary participants of both reporting systems, AMVER and JASREP will exchange ship routing information upon the specific request of the vessel's master. A vessel can report to one system by requesting transmission of the same message to the other system using one of the lines in the reporting message. The newly instituted service, like AMVER's voluntary participation, is also voluntary and free of cost.

AMVER is an international search and rescue system that maintains a plot of vessels underway around the world for safety purposes only. In the event of a distress, recognized search and rescue authorities anywhere in the world can obtain AMVER's valuable information and use it as a tool to respond to maritime emergencies. JASREP, the Japanese regional reporting system, began operating October 1, 1985 under the auspices of the International Maritime Organization.

TOGA DRIFTER PROGRAM

On January 1, 1985, a 10-yr scientific study sponsored by the World Climate Research Program (WCRP) called the Tropical Ocean Global Atmosphere (TOGA) program was launched. TOGA is an extensive research effort designed to acquire an environmental data base with which to try to improve prediction of regional climatic changes. The main effort will be to derive a clearer understanding of the large-scale oscillations, such as the El Nino Southern Oscillation (ENSO), that are present in the atmosphere and the oceans. TOGA is a major scientific endeavor and is crossing the boundaries of many disciplines, especially in the realm of ocean/atmosphere interactions.

The United States and several other nations are cooperating to establish a global environmental data base for the duration of TOGA. One of the major contributions by the United States will be to provide up to 80 drifting data buoys that will be used to increase the observational coverage of the Southern Hemisphere.

In addition to providing the buoys, the

United States, through the National Data Buoy Center (NDBC), has established cooperative agreements with the United Kingdom, Australia, New Zealand, and other countries to place into effect a global logistics plan for the deployment from ships and aircraft of an array of drifting buoys in the Southern Hemisphere (fig. 30).

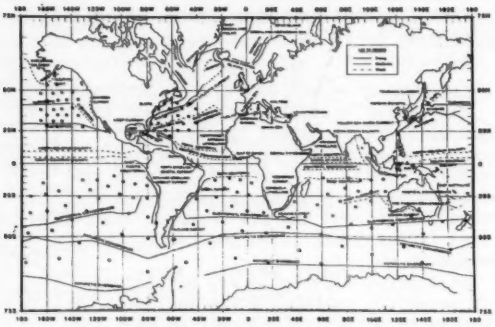


Figure 30.-- Global drifting buoy network.

In preparation for the inauguaration of TOGA, drifting buoys configured to measure barometric pressure, air and sea surface temperatures, and current drift were prepared for deployment in late 1984.

Initial deployments were made from the South African research vessel, AGULHAS, in early October, followed by deployments from the U.S. Coast Guard icebreakers POLAR STAR and GLACIER supporting the Antarctica resupply effort in November and December. Subsequent deployments are now being carried out from contract merchant vessels of the Military Sealift Command (MSC) (USNS MAUMEE and GREENWAVE) and the United Kingdom's Royal Fleet Auxiliary OLNA. As of April 1, 1985, approximately 62 buoys had been deployed into the remote mid-latitude region of the entire Southern Hemisphere. Eighteen additional buoys are scheduled for deployment by Australia and New Zealand for array maintenance and reseeding during July-November 1985.

Activities at this level are planned by the United States for the duration of TOGA to maintain an array of at least 40 operational buoys, exclusive of those provided by other nations. Overall, the combined activities of the United States and other nations will lead to the establishment of a desired array of deployed buoys along the ships' tracks, as shown in figure 31, to fill the drifting buoy data requirements for TOGA.

Although TOGA is a scientific program, the data obtained from the drifting buoy array is of operational significance, and will contribute to the day-to-day observational coverage of the Southern Hemisphere. Measurements made by the TOGA drifting data buoys are telemetered via the NOAA/TIROS-N series polar-orbiting satellites to ground stations in the United States and France. The data are processed by Service Argos of the

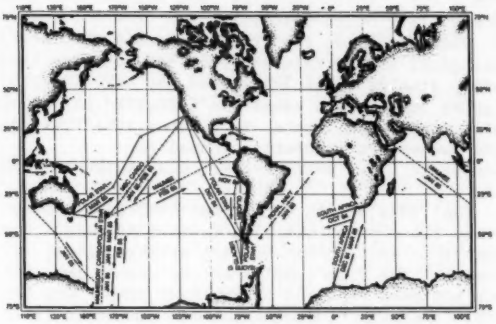


Figure 31.-- TOGA preliminary ship tracks.

Centre National d'Etudes Spatiales (CNES) in France and distributed in DRIBU code via the Global Telecommunications System (GTS) for operational use in analysis and forecasting. All data acquired by the United States drifting buoys will be archived at the National Climatic Data Center (NCDC) located in Asheville, North Carolina.

New generations of drifting data buoys capable of measuring a variety of environmental parameters will be developed and field tested during TOGA. Recent advances include a standardized buoy system for the basic environmental measurements, wind speed and direction, new simplified aerial delivery techniques, and a prototype wave measuring system. Developments are also expected to lead to a miniaturized basic parameter drifter capable of being air-deployed from a wide range of aircraft configured to handle standard Airborne Expendable Bathythermograph (AXBT) equipment.

From the National Data Buoy Center Technical Bulletin by R.M. Partridge.

MAGIC IN A DROP OF WATER

E. Arlo Richardson, Climatologist Emeritus
Utah State University, Logan UT

From Weekly Weather and Crop Bulletin, June 11, 1985.

In oceans, ice fields, lakes and rivers, we find one of the most common substances known to man, water. Estimates of 324 million cubic miles of water are in these bodies. Beneath the surface of the earth, lies some 2 million cubic miles more in ground water. Also, the atmosphere holds another 3,100 cubic miles mostly in water vapor. This abundance of water was present when the earth was created. Today, life as we know it could not exist without it. A few organisms on the earth can exist without air but none without water.

As a substance, water is ordorless, tasteless, and colorless. Yet, it plays a dominant role in the affairs of the world. As a chemical, it is a compound of unusual stability. Water is one of the most universal solvents known and a powerful source of

chemical energy. Water draws away from most organic substances but is strongly attracted to most inorganic materials including itself. It's molecules cling together more strongly than those of some metals.

Water has a few other unique characteristics. When frozen into a solid mass, it expands instead of contracts as most other substances. Thus, the lighter solid floats on the heavier liquid with some very astonishing consequences. Water can absorb and release more heat per unit mass of the substance than most other common materials. Water requires about 80 calories of heat energy to melt a gram of ice and 540 calories to convert a gram of water to vapor without any change in the temperature of the substance. A gram is roughly a teaspoon of water. Nearly all of these unique characteristics are a vital part of life processes.

Most known substances tend to contract or become more dense as the temperature decreases. Water follows this rule as a vapor and as a liquid for 96 percent of the way down the temperature range from the point that vapor becomes a liquid. But at 39 degrees F something happens. As cooling continues, water expands and becomes less dense. Also, as water freezes at 32 degrees F, it becomes ligher still until it has increased in volume by about 9%.

This increase in volume, with decreasing temperature below 39 degrees, causes some severe problems for the homeowner faced with burst water pipes in the middle of the winter, but it is indeed fortunate for most creative processes. If water behaved like other freezing liquids, there would soon be no life on the Earth. Almost all water would soon be locked up in the enternal ice or on the beds of seas, lakes and streams.

When winter comes, the ice forms and floats on the surface of the liquid water and protects the water beneath from further freezing. If the ice were heavier than water, it would sink to the bottom and gradually build up from there. Before long, the lakes and Arctic seas, would be frozen solid, with perhaps thin layers of liquid water over the ice where it melted during the warmer seasons. If such were the situation, most of the world's water supply would be unavailable for use by living organisms including plants, animals and man.

As the situation now exists, the water reaches it's maximum density while still in the liquid state. This heavier water sinks to the bottom of the ocean, lake or reservoir carrying with it the oxygen, carbon dioxide and minerals which it has obtained as part of the hydrologic cycle. This transfer occurs twice each year and is known as "seasonal overturn." The process helps to maintain the liquid state of the water by transferring energy throughout the system and supplying organisms with the oxygen, carbon dioxide and nutrients that they need to grow and survive in the depths of the oceans and lakes. This process also helps to maintain the water in a liquid state.

CHANGES OF STATE

In the change of water from a liquid to a gas, molecules escape from the surface of the liquid and enter the air as water vapor. The rate of their escape increases as the temperature at the liquid's surface increases. This is a simplified explanation of "evaporation," the process through which water vapor enters the atmosphere from liquid water.

Any change of state involves a heat transaction. In breaking away from the attraction of the other molecules, the escaping water molecules must do work and use energy, thus cooling the remaining liquid. The heat required for the evaporation process is not lost, but remains hidden or latent in the water vapor. When the vapor changes back to liquid water, this heat reappears. The more rapid the rate of evaporation, the greater is the cooling of the surface from which the heat is drawn.

During a period of high temperatures, light winds, and high humidity, weather conditions tend to become oppressive. At such times, the body's perspiration evaporates very slowly and therefore produces little cooling. When we use a fan for cooling purposes, it moves away vapor-laden air near the skin, replacing it with drier air. As moisture in the skin evaporates into the drier air, much of the heat necessary to evaporate this moisture is removed from the skin, thus cooling the body more effectively.

Heat is also required to melt ice or snow into liquid water. Upon freezing, the same heat is released. Thus evaporation and melting both cool the air, or at least retard temperature increases that may be produced by other processes occurring simultaneously. Conversely, condensation (change of water vapor to liquid) and freezing raise the temperature of the air, or at least retard its rate of temperature decrease.

It is possible for ice to change directly to water vapor without passing through the liquid state. Many of us have at times observed the disappearance of snow on the ground with no melting. This process, called "sublimation," is somewhat like evaporation, but more heat energy is required for the escape of molecules from solid surfaces than from liquid surfaces. The heat required to sublimate a given amount of ice is the sum of the heat required to melt it and that required to evaporate the liquid water (even though no melting or evaporation takes place). Solid forms of precipitation, in addition to snow and ice surfaces, supply water vapor through the sublimation process. The amount of water vapor added to the atmosphere by the sublimation process is small compared to that added through evaporation.

Ice can form diectly from water vapor. This process, which is the reverse of that described in the preceding paragraph, is also called sublimation, and is exemplified by the formation of frost on a cold, clear night.

MARINE WEATHER REVIEW

The Weather Logs combined with the cyclone tracks, U.S. Ocean Buoy climatological data, gale and wave tables, and mean pressure patterns are a definitive report on the weather systems and primary storms which affected the North Atlantic and North Pacific Oceans during this 3-mo period. Hurricane Alley lists and describes tropical cyclones worldwide. Unless stated otherwise, all winds are sustained winds and not gusts; all times are G.M.T.

North Atlantic Weather Log
April, May and June 1985

WEATHER LOG, APRIL 1985 — There were a mix of storm tracks across the Great Lakes, mostly the first half of the month, from the southwest clockwise to the northwest. There was a primary storm path from south of Cape Cod (40°N, 70°W) to the south coast of Iceland. There was a secondary track from near 45°N, 25°W to southern Norway. One storm crossed the Greenland Icecap near 66°N. One cyclone crossed the southwest coast of France into central Europe, two cyclones formed in the vicinity of northern Italy and moved eastward, and there were three cyclones over the desert of North Africa. Two cyclones formed southeast of Bermuda but did not develop.

The gross mean sea-level pressure pattern did not depart radically from climatology but there were significant anomalies (fig. 32). The Icelandic Low was elongated east-west with multiple centers and an anomalous bulge over northern Scandinavia and northern Russia. These were three 1005 mb low pressure centers, 55°N, 50°W; 60°N, 33°W; and 70°N, 34°E. There was a 1030 mb Polar High over the Arctic Ocean north of the Bering Strait. The Azores High was 1024 mb near 32°N, 36°W.

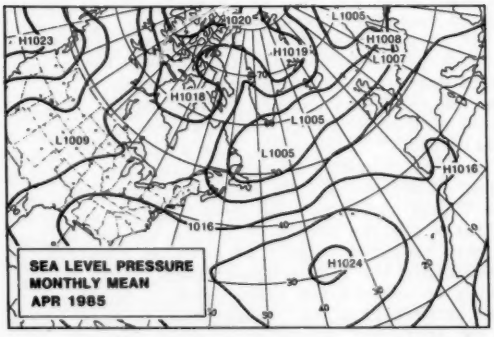


Figure 32.— Monthly mean sea-level pressure.

The anomaly centers were not particularly large but interesting. The largest was minus 11 mb over northern Russia at 60°N, 60°E. There was a minus 6 mb center north of Newfoundland and a minus 3 mb center over Lake Superior. The Azores High produced a plus 3 mb center near 31°N, 38°W. The Polar High resulted in a plus 10 mb center near 80°N, 175°W.

In the upper air at 700 mb there are normally two cyclonic circulation centers, one over Ellesmere Island and the other over the Severnaya Islands. This month there were four. The first two were near normally located. The third was over western Alaska and the fourth off Hamilton Inlet, Labrador. This fourth center deepened the trough off the North American coast and enhanced a ridge over Iceland and Greenland. The normal trough over central Europe occurred only south of latitude 45°N and at longitude 15°W.

Some Climatology — On April 2, 1975 the northeastern U.S. was in the grip of a severe storm that produced hurricane-force winds along the coast. On the 13th, 1877 the second coastal storm in 3 days struck Virginia and the Carolinas. Hurricane-force winds along the coast caused beach erosion and land transformation.

Extratropical Cyclones — The month started with a large LOW covering most of the North Atlantic north of latitude 25°N. On the 2d the pressure was down to 955 mb. At midweek the storm was near 55°N, 25°W and weakening. High pressure was over the Mediterranean, centered at 30°N, 35°W, and over the Gulf of Mexico. Frontal waves were racing eastward along the 40°-45°N latitude belt. At the end of the week a multicentered storm was west of the European coast. High pressure was over Bermuda.

The beginning of the second week the storm had moved over the North Sea. There was a strong HIGH over the central ocean. By midweek a weak LOW from near New York City had formed a strong LOW between Kap Farvel and Iceland. A strong 1040 mb HIGH was over the Azores. Another strong LOW was south of Kap Farvel at the end of the week. High pressure was over the North American coast and west of Spain.

The last named LOW moved northeastward the third week. The North American HIGH moved southeastward and the eastern HIGH was near Cape Finisterre. By midweek another LOW was over Newfoundland. A LOW had formed west of Spain, and a HIGH was southwest of the Azores. At the end of the week a LOW was blocked by high pressure south of Iceland and

weakening. A high pressure cell stretched from Florida to the Canary Islands. A large weak low pressure system covered the Mediterranean.

The fourth week a high pressure block at the surface and an omega block in the upper air stretched from east Greenland to south of the Azores. Lows were weak. At midweek a LOW that formed in an area of weak gradient off Nantucket intensified and moved northward. The high pressure block persisted to the end of the month.

This first storm actually formed late on March 30 over Cabot Strait. It moved southeastward through the northwest flow of an old LOW south of Kap Farvel. At 0000 on April 1 the new LOW was the primary center at 960 mb near 43°N, 40°W. The SANKO AZALEA (39°N, 42°W) measured 53-kn northwest winds, 26-ft seas, and 31-ft swells from 270°. The ADMIRAL CALLAGHAN (42°N, 45°W) reported 50-kn northwest winds, 20-ft seas, and 35-ft swells from 310°. At 0000 on the 2d the storm was 948 mb (fig. 33). The SEALAND PRODUCER (42°N, 45°W) found 55-kn winds and 20-ft seas. The DRYSO (40°N, 43°W) measured only 40-kn but had 31-ft seas. Waves near 20 ft were being reported in all quadrants. CHARLIE was having seas over 20 ft. On the 3d ROMEO had 25-ft seas and the ALEMANIA EXPRESS (47°N, 24°W) had 44-kn southwest winds, 13-ft seas, and 30-ft swells. The TFL EXPRESS measured 44-kn winds and 23-ft seas on the 4th near 45°N, 25°W. The storm was now stationary near 56°N, 20°W where it remained until dissipating on the 7th.

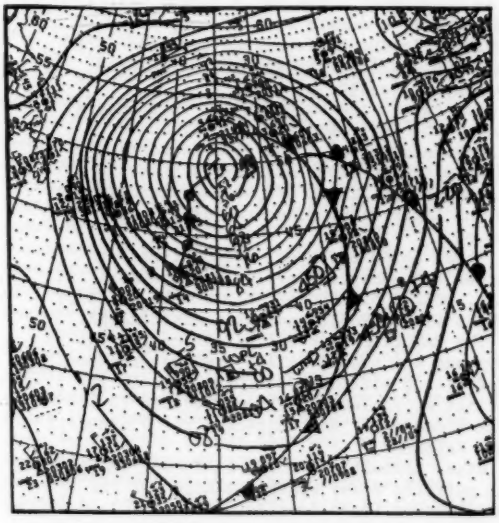


Figure 33.--Surface analysis for 0000, April 2.

This LOW formed near New York City n the 8th in a trough from a LOW moving eastward over Quebec. This storm moved northeastward as the northern LOW turned northward over the Labrador Sea. Several ships and platforms on the Grand Banks reported gales. The VINLAND (46°N, 48°W) had 45-kn southwest winds on the 9th. At 1200 on the 10th the storm was 966 mb near 62°N, 31°W. CHARLIE had gale-force winds and 20-ft seas. The FETISH (55°N, 28°W) had 45-kn west winds and 20-ft seas. The storm weakened rapidly as it passed south of Iceland but maintained its identity until near Murmansk on the 15th.

This LOW formed very much like the previous storm and near the same area, on the New Jersey coast 36 hr later, at 1200 on the 9th. At 1800 on the 10th the center was south of Cape Race and the AMERICAN ENVOY (41°N, 56°W) found 55-kn winds from the west and 20-ft swells. By 1200 on the 11th the storm had raced to 51°N, 45°W at 984 mb. The FETISH, still near 55°N, 29°W now had 50-kn winds and 30-ft seas. The NURNBERG EXPRESS (49°N, 37°W) had 52-kn southwest winds, 13-ft seas, and 23-ft swells.

At 1200 on the 12th the storm was 968 mb near 59°N, 22°W. The KOLN EXPRESS (49°N, 23°W) reported 47-kn winds, 26-ft seas, and 30-ft swells. CHARLIE measured 35-kn winds and 30-ft waves. On the 13th ROMEO measured 23-ft waves. There were several strong gale and waves near 25-ft reports south of Ireland. The storm was over the North Sea on the 14th and rapidly weakened.

The Yukon Territory of Canada produced this LOW on the 8th. It took 4 days to reach the Atlantic. On the 13th it was bring gales to the Grand Banks. The VCNP (47°N, 48°W) had 42-kn west winds. On the 14th CHARLIE measured 43-kn winds and 25-ft seas. The high waves continued into the 15th. At 1200 on the 14th the storm was 977 mb southeast of Kap Farvel.

On the 15th a frontal wave formed on the cold front near 47°N, 30°W. It moved northward and on the 16th was the primary center and storm. It was 980 mb on the south coast of Iceland at 1200 on the 16th. The VAN WARRIOR (59°N, 15°W) measured 45-kn winds and 33-ft seas. The original LOW disappeared on the 18th between Greenland and Iceland. The new storm also disintegrated on the 18th off northern Norway. Isolated fishing vessels reported gales.

Another long-lived storm that spent more time over land then water. It had its beginning over the Rocky Mountains on the United States-Canadian border on the 11th. Its circulation started affecting the marine area on the 16th. On the 14th and 15th it had moved over the Great Lakes. On the 14th the ALGOPORT radioed winds of 40 kn from Lake Huron. On the 16th the RICHELIEU had 36-kn winds from the northwest on Lake Superior. Late on the 16th the ships and platforms on the Grand Banks were reporting winds of 40-kn.

At 1200 on the 17th the storm was 977 mb near 50°N, 61°W. The WGZL (47°N, 49°W) had 52-kn south winds. Winds reached 53-kn at Caribou, Maine and gusted to 60-kn at

Rockland, Maine. There were many gale reports on the 18th. The NANO KISHORE (47°N, 60°W) had 50-kn winds with 25-ft swells. On the 19th and 20th the storm was quasistationary and disintegrated by the 21st. On the 20th the EVER GENTLE (42°N, 51°W) had 51-kn southwest winds and 20-ft swells.

The pressure pattern off the U.S. East Coast was weak with multiple LOWs. A frontal wave about 700 mi east of Norfolk, VA on the 23d continued to develop. Twenty-four hours after it was first analyzed the LOW was 980 mb at 1200 on the 24th (fig. 34). The WILFRED TEMPLEMAN (46°N, 49°W) north of the storm measured 59-kn east winds and 20-ft seas and swells. The VINLAND and WGZL, both near 47°N, 48°W, had winds of 60 and 63 kn respectively. Some ships in the southeast quadrant had 20-ft waves. The storm was weakening on the 26th but regained strength over the Labrador Sea on the 27th and managed to cross the ice cap of southern Greenland.

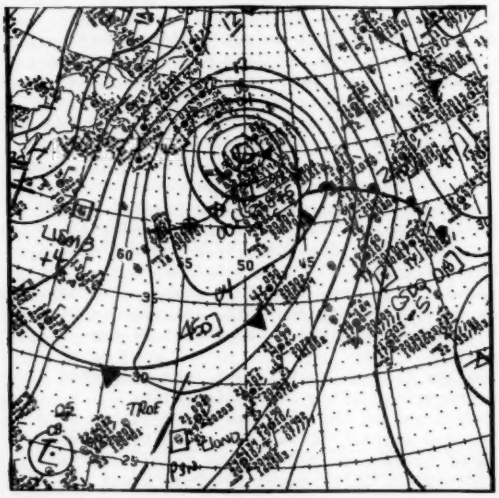


Figure 34.-- Surface analysis 1200, April 24.

This storm developed over the Denmark Strait on the 25th. It moved southeastward and was over the North Sea on the 26th. Late in the day there were reports of gales. The SELA (61°N, 05°W) had 44-kn northwinds. There were many reports of gales and some of winds over 60 kn with waves as high as 52-ft on the 27th. At 1200 the storm was 980 mb near 58°N, 09°E (fig. 35). One of the higher wind reports was 60 kn by the WESTERN PACESETTER I (58°N, 01°E). A RIGG at 57°N, 02°E reported 52-ft waves. As the storm continued southeastward on the 28th and the center moved over land the winds gradually decreased. The WPIV (58°N, 02°E) had 50-kn winds and 25-ft waves. The SEAGAIR (62°N, 01°E) had 39-ft waves. The storm was no longer of consequence to mariners on the 29th.

On the 27th the THALASSA sank near 50°N, 04°W. All five crew were rescued when the

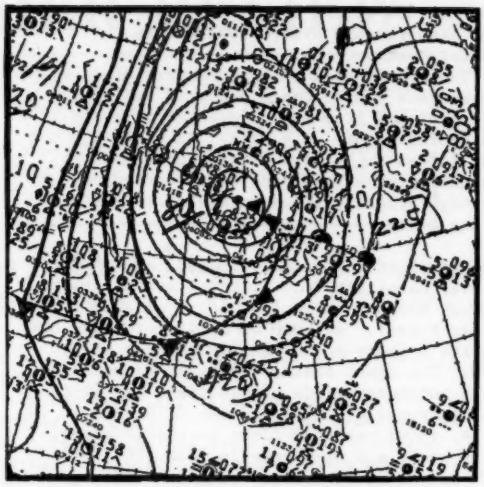


Figure 35.-- Surface analysis 1200, April 27.

aircraft carrier ILLUSTRIOUS spotted a flare. The HAVDRON at 60°N, 01°E had the wheelhouse demolished by a large wave late on the 27th. One crewman was injured.

Casualties -- Damage from ice was a major factor this month. There were five incidents in the Baltic Sea. The ALINDA, FRAUDEN, HYDRO, and KARLSVIK were damaged. The SALLA was holed by the ABAKANLES when she could not maneuver in ice. The crew of 28 were rescued by an icebreaker. The SALLA caught fire and was towed to a sunken rock to keep her from sinking. In the Newfoundland area the OCEAN CHALLENGE, LAZARO PENA and LOK NAYAK were disabled or damaged in ice.

Fog caused the KOLOGRZEG II to ground at Malmo. The SAN FRANCISCO and ORTIGUERA collided near Weser. The fish factories JOHANN DIETRICK BROELEMANN and WESERMUNDE collided about 225 mi off Newfoundland in fog and the later sank. The crew of 63 was rescued.

These ships suffered various types of weather and damage. They were the ALASKA II, DELIA, DORTHE OLDENDORFF, HAPPY MED, INIOCHUS EXPRESS II, MABROUK, and MARIA AUXILIADORA.

The CAROLINE sank off LIZARD on the 7th in heavy sea and swell. All 8 crew was rescued. The drilling platform J. STORM VI broke its moorings at Ingleside, TX on the 10th in a freak windstorm. She contacted the STORMDRILL V and KATHLEEN.

Other Casualties -- The KARIN and GENERAL PAEZ suffered heavy weather damage off the east coast of South America.

WEATHER LOG, MAY 1985 -- There were a lot of cyclone tracks this month for a Spring month. Many of the cyclones took individual paths, not following a preferred path. There were more than the usual number of cyclones that tracked against or across the prevailing

direction. The only primary path was from off the East Coast of Virginia, to Newfoundland to the Denmark Strait. Two cyclones came out of the Sahara Desert into the Mediterranean. A cyclone that formed near Barcelona looped over southern France and ended over Denmark. There were four cyclones in the Azores area.

The largest sea-level pressure feature was the Azores High at 1024 mb near 30°N, 40°W (fig. 36). The Icelandic Low was 1006 mb, near 57°N, 50°W. This was about 500 mi east of its normal location and 3 mb deeper. There was an anomalous 1012 mb Low over southwest Germany.

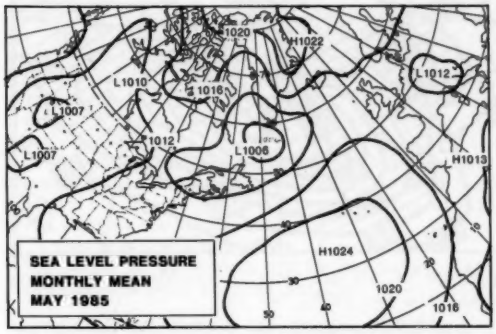


Figure 36.-- Monthly mean sea-level pressure.

The major sea-level pressure anomaly centers were off the primary shipping routes. The Icelandic Low produced a minus 7 mb center 57°N, 50°W. There was also a minus 4 mb center over northern Italy. The only significant positive anomaly center was 5 mb over Nordkapp.

The center of circulation in the upper air at 700 mb was near 58°N, 57°W, about 1200 mi southeast of its normal position. The wind flow over the western half of the ocean was near zonal between 30°N and 50°N. There was an anomalous High over Scoresby Sound with accentuated ridging over Greenland. The normal trough along the Portugal and Morocco coast was sharper than normal and extended northward to the Faeroe Islands rather than just to the Bay of Biscay. The northern part of the trough was shifted eastward over England and France.

Some Climatology. On May 12, 1894 a violent Lake Michigan storm wrecked nine ships. On May 16, 1834 the greatest May snowstorm ever hit New York and New England. Areas in Vermont had 2-3 ft of snow. On the 19th in 1780 the famous dark day in New England tradition occurred. It was nearly dark as night at noon. The phenomena was caused by smoke from forest fires to the west.

Extratropical Cyclones -- The cyclones except for three exceptions were weak but there were more total than usual. The month began with high-pressure cells across the subtropic latitudes and LOWs across the Polar latitudes. At midweek a large multicentered LOW covered Europe. A large HIGH had consolidated over the central ocean near 45°N, 35°W. A strong LOW was moving along the North American East Coast. At the end of the week the HIGH had moved to the normal Azores location.

The second week started with another LOW covering Europe and high pressure over Scandinavia. At midweek there was a Bermuda High. Near the end of the Week the HIGHs combined and a ridge connected with the HIGH over Scandinavia. A significant LOW was moving eastward along latitude 55°N. At the end of the week the HIGH had retreated southward. The LOW had turned westward and the cyclone track was now along latitude 45°N.

The strongest storm of the month occurred the first part of the third week - 15 to 18. There was high pressure north of Iceland, the Azores High and a HIGH moving out of the Maritime Provinces of Canada. At midweek high pressure over the southern Norwegian Sea blocked the sotrm and it turned northward. A blocking HIGH was over the midocean at the end of the week.

The fourth week started with multiple weak pressure systems. By midweek two significant LOWs broke through the middle of the blocking HIGH. Other LOWs followed along latitude 40°N. At the end of the week and the month there were again multiple weak systems.

This LOW was over the Midwest on the 1st day of May. It moved off the Delaware coast on the 3d. At 1800 the ATLANTIC SUPERIOR found 50-kn winds just off Cape May. On the 4th there were many gale reports (fig. 37). A ship that was probably the NAVICULA was near Cape Sable with 50-kn winds. Later in the day there were more storm-force winds. The VINELAND had 50-kn winds on the Grand Banks. The ZIEMIA KRAKOWSKA (39°N, 56°W) had 40-kn south winds and 21-ft seas. At 0000 on the 5th the storm was 976 mb near 50°N, 56°W. Storm-force winds were continuing. The WGZL (47°N, 48°W) measured 49-kn south winds. On the 6th the storm was over the Labrador Sea. The NAJA ITTUK (58°N, 42°W) had 37-kn winds. There were no other reports but probably

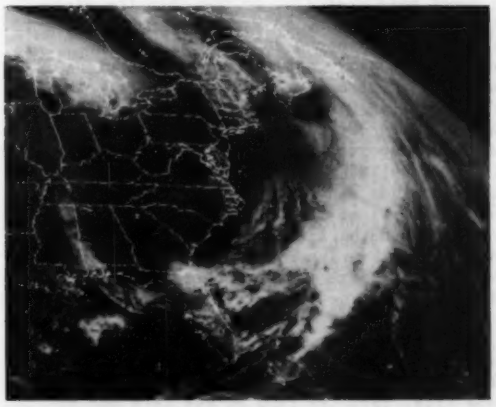


Figure 37.-- Satellite image at 1700, May 4.

because of scarcity of ships. At 0000 the 7th the storm was still 980 mb and moving northward and weakening. The storm died over Davis Strait on the 8th.

This was the only storm that the center passed over the Great Lakes and continued to the Atlantic. The storm moved off the coast of Maine on the 7th and gained strength. At 1200 on the 8th the storm was centered over Newfoundland. The WGZL (47°N, 49°W) had 44-kn winds from the southwest. Most of the gale reports were from the Grand Banks. On the 9th the WYG7 (44°N, 60°W) reported 48-kn west winds. SEDCO 706 (44°N, 59°W) measured 36 kn. On the 10th the storm moved along the southeast coast of Greenland at 988 mb and ended on the 11th.

The area west of Lake Winnipeg produced this storm on the 8th. It tracked eastward and was near Hamilton Inlet on the 11th. It already had a good circulation on the 10th. At 1800 the KNDH (44°N, 60°W) had 48-kn winds.

At 1200 on the 11th the cyclone was 990 mb near 55°N, 52°W. There were many gale-force reports in the south and southeast quadrants. The KSCP (44°N, 60°W) and the WGZL (47°N, 49°W) both reported winds of 55 kn but the waves were only up to 12 ft. The storm was still moving eastward at 1200 on the 12th when it was 988 mb near 56°N, 44°W. The winds were all in the gale category. The VIKTOR BUGAYEV (50°N, 41°W) measured 39-kn south winds and 23-ft seas. On the 13th her winds were 43 kn and seas 26 ft. CHARLIE had 23-ft seas. The storm now turned northwestward and died out.

An east-west front with frontal waves approximated latitude 40°N. At 1200 on the 14th a frontal wave was analyzed south of Cape Sable. At 1800 the DYUI SKAGERAK (40°N, 46°W) measured 44-kn winds, 8-ft seas, and 25-ft swells. At the same time on the 15th the winds were 61-kn from 300°, 25-ft seas, and 33-ft swells. At 1200 on the 15th the storm was 990 mb near 44°N, 46°W (fig. 38). The NEDLLOYD ROUEN (39°N, 52°W) had 41-kn winds and 20-ft seas. At 1200 on the 16th the storm was 968 mb near 48°N, 43°W. The SALMONPOOL (45°N, 43°W) was about 200 mi south of the center of the storm and reported 65-kn winds from 250°, 46-ft seas, and 59-ft swells. The PORT QUEBEC (45°N, 41°W) reported 56-kn winds from 240°, and 39-ft seas. At 1800 the SALMONPOOL reported 60-kn winds, 36-ft seas, and 46-ft swells. The CHAMPLAIN (47°N, 44°W) had 55-kn winds and 41-ft seas. The waves were only 30-ft on the 17th.

At 1200 on the 17th the 976 mb storm was near 54°N, 43°W. The PORT QUEBEC now had 33-ft swells. High pressure over the Norwegian Sea turned the storm northwestward and it quickly lost strength.

On the 17th there was a complex low-pressure system over the eastern United States and Canada (fig. 39). By 1200 on the 18th one of several low-pressure centers was the dominate

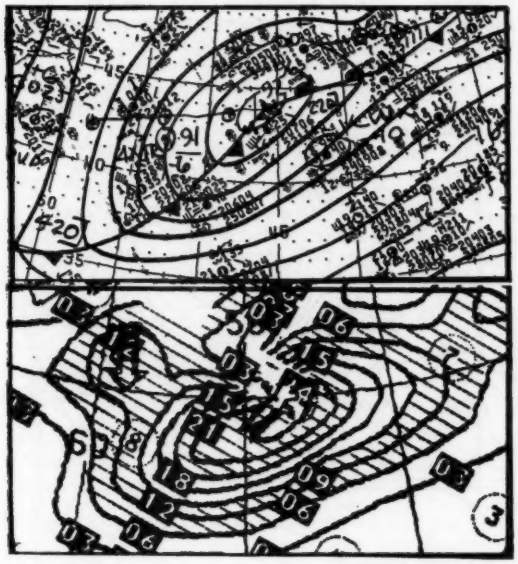


Figure 38.-- The sea-level pressure and wind wave analysis for 1200, May 15.

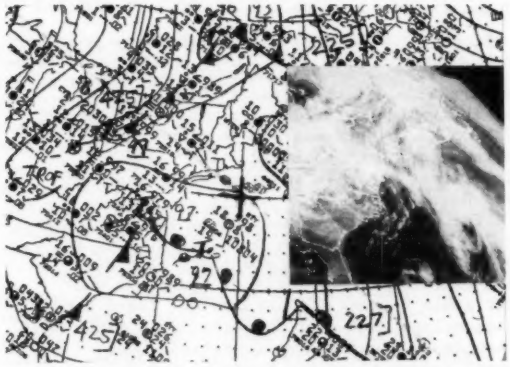


Figure 39.-- The 1200 surface analysis and 1700 satellite image for May 17.

one. It was 992 mb near 41°N, 70°W. The DYUI SKAGERAK (36°N, 67°W) measured 60-kn winds from the south-southwest, and 21-ft waves. The CGRG (39°N, 64°W) measured 54-kn north winds and 20-ft seas. At 0625 Newark, NJ had a barometric reading of 29.23 inch of mercury (990 mb), the lowest ever recorded in May. By 1200 on the 19th the storm was 991 mb north of Quebec. The KSCP (44°N, 60°W) measured 50-kn south winds. The VSBC (47°N, 48°W) measured 49-kn winds. On the 20th the storm was dissipating.

The point of occlusion of a frontal system produced this LOW over Newfoundland on the 20th. The weak LOW traveled southeastward until the 23d when it became imbedded in a large cyclonic circulation associated with two other LOWs to the northeast. The RAVNI KOTARI (41°N, 38°W) had 42-kn west winds and 20-ft

seas. At 1200 on the 24th the storm was 988 mb near 42°N, 27°W. A second LOW In the circulation was over the Outer Hebrides. The HUDSON (36°N, 33°W) had 42-kn winds. The higher winds were gales and waves less than 10 ft. The storm was moving northeastward on the 25th. Two ships reported winds near 45 kn. They were the INCOTRANS SPEED (48°N, 23°W) and FARLAND (45°N, 26°W) both with 23-ft waves. On the 26th ROMEO had 20-ft seas. The SEA-LAND PIONEER (46°N, 17°W) found 40-kn winds. The storm was weakening and died out over Ireland on the 27th.

Casualties -- The WASA EXPRESS returned to Sundsvall after ice damaged the rudder on May 2. The ESTA-FLO III and the PUBNICO GEMINI collided in fog 5 mi east of Nova Scotia. The REEFER MERCHANT ran aground near Key Biscayne during a rainstorm on the 25th. The MARJOBIL listed 50° when deck cargo shifted in rough seas off Suez.

The ANNY DANIELSEN reported heavy weather damage on the 16th. The tug POINT SPENCER had weather damage on the 17th while towing a ship from Norfolk to Castellon.

The trawler HAN SUNG No. 2 sank on the 15th at 20°N, 17°W when hit by two waves. All crew-members were rescued safely.

WEATHER LOG, JUNE 1985 -- There were only a few cyclone tracks over the North Atlantic this month with no concentrated path. Most of the storms were concentrated over Canada. There were seven cyclones over the southeastern ocean where few normally occur. They were west of Portugal and both north and south of the Azores. There was a slight concentration of cyclone centers over Scotland.

The monthly mean sea-level pressure pattern differed radically from the climatic mean north of latitude 40°N (fig. 40). There are normally two 1009 mb LOWs with the Icelandic Low. One east of Cape Chidley and one east of Kap Farvel. A 1011 mb LOW is normally over Lapland.

This month the deepest LOW was 1007 mb over James Bay. A 1011 mb LOW was north of Hopedale and a small 1012 mb center slightly south of Iceland. The Lapland Low was 1006 mb about 900 mi southeast of its normal position.

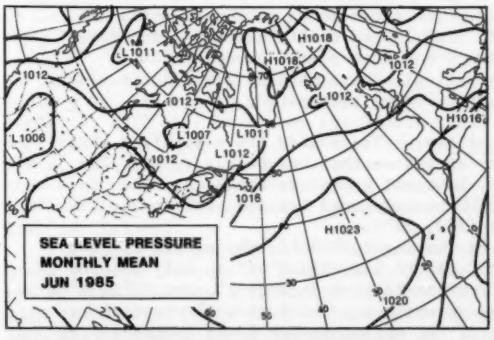


Figure 40.-- Monthly mean sea-level pressure.

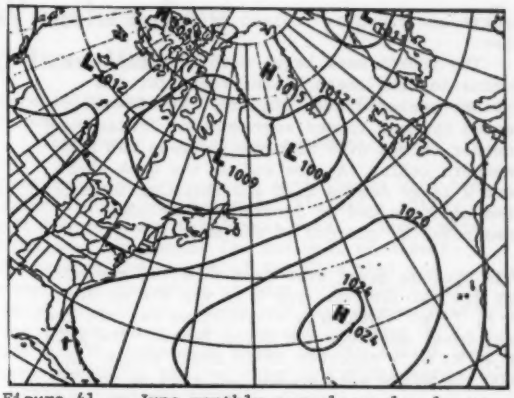


Figure 41.-- June monthly normal sea-level pressure, 1948-1970.

The usual HIGH over northern Greenland was 1018 mb and stretched further south than normal. The Azores High at 1023 mb was near normal in pressure and location at 31°N, 35°W. The anomalous LOWs in that area did not significantly affect the mean.

The anomaly pattern was interesting (fig. 41). The pressure over the ocean north of latitude 43°N was generally above normal. There was a plus 5 mb anomaly center near 51°N, 32°W, another near 62°N, 38°W and a third near 71°N, 00°. There was a minus 6 mb anomaly center near Moscow and a minus 4 mb center over James Bay.

The mean upper-air pattern at 700 mb was near normal, not significantly reflecting the surface pattern. The flow was near zonal between 30°N and 50°N off North America and between 45°N and 60°N off Europe.

Some Climatology -- On June 18, 1875 a severe coastal storm, possibly a hurricane, struck the East Coast from Cape Cod to Nova Scotia. On June 22, 1972 hurricane Agnes deluged Pennsylvania and New York with torrential rains. It was the most costly flood in the U.S. history and 117 persons perished.

Extratropical Cyclones -- June started with high pressure stretching from Greenland to the Azores. There were LOWs over eastern Canada, the Norwegian Sea and North Africa. By midweek a HIGH southeast of Kap Farvel had increased to 1038 mb and continued to the end of the week. A storm over Nova Scotia was producing gales.

The northern HIGH started drifing south the second week and weakening. Two LOWs moved over the top of the HIGH. Two LOWs also formed near the Azores. At midweek a large LOW was moving off Newfoundland and another was over England. The week ended with many weak pressure systems.

As the third week started (21st) another cut-off LOW formed near the Azores. A cyclone was moving northeastward from Newfoundland as high pressure moved over England. At midweek the pressure pattern had a near normal configuration. A LOW moved eastward from Nova

Scotia and raced to Ireland by the end of the week.

The fourth week began with high pressure dominating the ocean basin except for the cyclone centered over England. At midweek a second cyclone formed southwest of Iceland and another formed over midocean between two high pressure cells. At the end of the week there were a large Azores High and three cyclones from off Cape Cod to Scotland. The LOWs dissipated by the end of the month.

This cyclone moved over Lake Superior the on May 31. At 1200 on June 1 it was 986 mb near 50°N, 77°W. Southerly circulation was off the East Coast and over the Grand Banks. The KNDH at 44°N, 60°W reported 38-kn south winds. At 1800 the winds were 45 kn. At 1200 on the 2d the storm was north of Sept-Iles. SEDCO 706 measured 37-kn winds. The storm turned northward and the higher winds were over the Labrador Sea. A Danish ship, OYRK, (65°N, 54°W) reported 37-kn southeast winds on the 4th. The storm was gone on the 5th.

A weak low pressure system had persisted near Vigo, Spain since June 1. On the 2d a weak frontal wave was north of the Azores and the LOW moved westward to combine with it. On the 4th another LOW formed and moved northeastward. The FERNGOLF (48°N, 25°W) found 35-kn north winds. At 1200 on the 5th the storm was 1004 mb west of Cape Finisterre. Several ships reported gales. The DYUI SKAGERAK (45°N, 23°W) measured 45-kn north winds, 20-ft seas, and 25-ft swells. The GUATEMALA (48°N, 25°W) had 38-kn northeast winds and 20-ft seas. By the 6th the storm had reverted to a frontal wave and sped over the English Channel.

This frontal wave formed south of Long Island on the 6th. It quickly deepened over the Gulf Stream. By 1800 the drilling rigs over the Grand Banks were having gales. The KSCP measured 44-kn winds from the southeast. The winds continued into the 7th and the KNDH measured 49-kn from the south. The storm was 998 mb at 1200 near Sydney. There were still gales up to 45 kn on the 8th. The storm dissipated on the 9th over the Labrador Sea.

A LOW formed over Virginia on the 8th and as with the previous storm intensified over the Gulf Stream. Late on the 9th there were gales over the Grand Banks. At 1200 on the 10th the storm was 998 mb south of Cape Race. The VSBC (47°N, 48°W) had 49-kn winds from the southeast. The gales continued into the 11th as the storm slowed its northeast track. The storm was weakening on the 14th and drifted south of Kap Farvel until absorbed by another storm on the 15th.

The next storm originated over the Great Plains on the 14th. Southerly flow was off the East Coast on th 16th and the center was over the Bay of Fundy on the 17th (fig. 42). By 1800 the rigs on the Grand Banks were having high winds. The KNDH (44°N, 60°W)

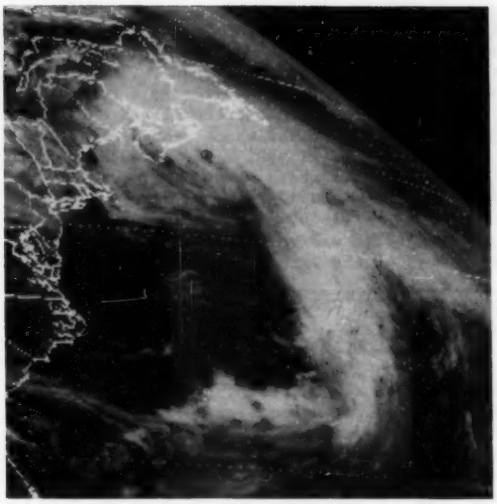


Figure 42.-- GOES satellite image 1700, June 17.

measured 54-kn winds from the east. On the 18th the QUEEN ELIZABETH 2 (42°N, 57°W) measured 37-kn west winds and 16-ft seas. By 1200 on the 19th the storm was 990 mb near 48°N, 37°W. The LONG LINES (44°N, 40°W) had 45-kn west winds and 23-ft seas.

At 1200 on the 20th the 987-mb storm was near 53°N, 23°W. The SEA-LAND ADVENTURER at 40°N, 27°W had 38-kn winds. The MUSSON (47°N, 26°W) had 39-kn winds and 20-ft seas. ROMEO had 21-ft seas. On the 21st they were 26 ft. The SEA-LAND PRODUCER (48°N, 18°W) had 40-kn winds, 13-ft seas, and 20-ft swells. The storm was over northern Ireland on the 22d. An English ship at 51°N, 08°W had 44-kn west winds, 23-ft seas, and 30-ft swells. The storm dissipated on the 26th.

The CAROL loaded with scrap sank about 20 mi southwest of Ushant in heavy weather on the 24th.

A col area between two HIGHs produced the spin to start this cyclone on the 23d. By 0000 on the 25th the HUDSON (43°N, 42°W) had 44-kn northeast winds. At 1200 the FERNGOLF (46°N, 36°W) had 45-kn northeast winds and 20-ft waves. The storm moved northward until the 27th, then looped counterclockwise and moved eastward and then southeastward prior to dissipating. There were no significant winds reported during this period.

Casualties -- There were few casualties this month as the weather was fairly quiet. The CAROL sank off Ushant on the 24th. The PANDALUS encountered ice and sank on the 16th near 53°N, 52°W.

In the South Atlantic the search for the ARCTIC CAREER was called off on July 8. She was last heard from on June 25 near 31°S, 17°W in heavy weather. There were 27 crewmembers aboard. An aerial search found debris and an oil slick about 300 mi northeast of Tristan da Cunha.

North Pacific Weather Log
April, May and June 1985

WEATHER LOG, APRIL 1985 -- The storm track pattern differed significantly from climatology this month. In general the tracks were widely dispersed except for two areas. There was a concentration of tracks from near Tokyo eastward to 40°N, 165°E. This climatological track normally extends northeastward to Bristol Bay. The other concentration was from near Adak along the Aleutians and Alaska Peninsula into the southeast Alaska coast. A second track eastward across the central Bering Sea joined the above track over Bristol Bay. The first half of the month two cyclones invaded the Pacific High area north-northeast of Hawaii. The last week there were two cyclones along latitude 25°N over the central and west-central ocean.

The difference in the storm tracks from climatology was also indicated in the difference between the Aleutian Low on the monthly mean sea-level pressure chart (fig. 43) and the climatic monthly mean. The climatic normal Aleutian Low indicates four centers along a mean latitude of 55°N from the Gulf of Alaska to the Sea of Okhotsk of about 1009 mb. This month there was a single 1004 mb Low over the Gulf of Alaska near 57°N, 150°W. There was also a 1010 mb Low over northern Manchuria.

There was a strong 1030 mb High north of the Bering Strait. This was 10 mb higher than normal and displaced 45° longitude westward. The Pacific High was near normal in position and pressure over the eastern ocean but was up to 7 mb higher over the western half.

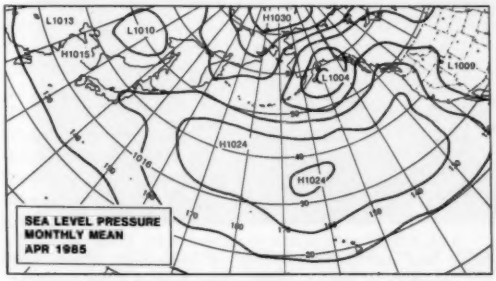


Figure 43.-- Monthly mean sea-level pressure.

There were three significant anomally centers as a result of the weather. Two were positive, a 10 mb center over the Arctic Ocean near 80°N, 170°W, and a 7 mb center near 47°N, 170°E. The two centers were connected by a plus 6 mb ridge approximately along longitude 170°E. The negative anomally center was minus 6 mb ner Valdez.

The upper air pattern at 700 mb was mainly zonal between latitude 40°N and 50°N. There was an anomalous Low over Norton Sound and a High center near 80°N, 180°. There were two long-wave troughs, one along longitude 127°E and another along 150°W. The normal ridge paralleled the North American Coastal Mountains.

There were no tropical cyclones.

Extratropical Cyclones -- April began with two large HIGHs along latitude 35°N and a third off the northern California coast. There were LOWs over the Bering Sea and Gulf of Alaska. By midweek the center of the HIGH that was over Japan had moved to near 40°N, 170°E and built to 1045 mb. There was high pressure off the Oregon coast and a cut-off LOW near 30°N, 150°W. The LOWs were weak. By the end of the week the HIGHs had collapsed and there were multiple pressure centers.

The LOWs consolidated as the second week began, two over the northern latitudes and another cut-off LOW north-northeast of Hawaii. At midweek there was a strong 1048 mb HIGH over the Arctic Ocean near 75°N, 175°E and a 1044 mb center over the northern Bering Sea with a tongue of high pressure south along the Date Line. This high pressure kept the LOWs over the midlatitudes, 40° to 45°N. At the end of the week high pressure persisted over the Arctic Ocean but the lower latitude HIGH moved east to join the Pacific High.

The third week found a LOW near Amchitka Island and developing into a strong storm. It was over the Gulf of Alaska at midweek and another storm was developing east of Japan and was over the Gulf of Alaska at the end of the week. There were two large HIGHs across latitude 35°N.

The two strong HIGHs with weak LOWs persisted into the fourth week. The high pressure moved northward across the entire basin and straddled 45°N by midweek with one large weak LOW over the Gulf of Alaska and a cut-off LOW south of and between the HIGH centers. The cut-off LOW broke through between the two 1040 mb HIGH centers into the Gulf of Alaska toward the end of the week but high pressure still was the dominate feature. The HIGH over the midocean continued to build to 1045 mb while the Pacific High weakened at the end of the month.

This storm formed on the 2d near 56°N, 162°W in the eastern circulation of another LOW centered over the Bering Sea. It intensified very quickly and was 980 mb at 0000 on the 3d near 58°N, 152°W. The GREEN FOREST (54°N, 161°W) measured 42-kn west winds and 25-ft seas. The UNISTAR (53°N, 144°W) had 42-kn south winds and 33-ft waves. On the 4th the DIANA (55°N, 140°W) measured 40-kn winds, 21-ft seas and 26-ft swells at 1100. The storm was over the Yukon and by the 5th no longer of concern.

Manchuria produced this cyclone on the 6th. It moved slowly eastward and was over the Sea of Okhotsk on the 10th and 11th. On the 13th the storm was 989 mb near 54°N, 173°E. The

PRESIDENT WASHINGTON measured 40-kn winds, 20-ft seas, and 13-ft swells. Another ship nearly had 44-kn winds, 25-ft seas, and 20-ft swells. By 0000 on the 14th the storm was 992 mb near 54°N, 168°W. The BUNGA MELAWIS (49°N, 159°W) measured 44-kn south winds and 20-ft waves. The storm was over Kodiak Island on the 15th. The QUEEN OPAL (49°N, 159°W) measured 40-kn south winds, and 23-ft seas and swells. By the 16th the storm was gone.

This LOW formed to the south of a cold Siberian High and moved off the coast of China on the 10th. As an aside, there was a large 1048 mb High over the Arctic Ocean at this time with a ridge that stretched south into the Tropics.

On the 12th the storm was over Shikoku. The STAR LUZON (33°N, 137°E) measured 41-kn northeast winds, 26-ft seas, and 28-ft swells. On the 13th the PRESIDENT MONROE (36°N, 146°E) had 40-kn winds from the northeast and 20-ft seas. These continued into the 14th. At that time the storm was 1000 mb near 39°N, 162°E. The storm was caught in strong southwest upper-air flow and sped off to the northeast. At 1200 on the 15th (fig. 44) it was 974 mb near 50°N, 177°W. The RICHMOND BRIDGE (47°N, 179°W) had 45-kn winds. the GOLDEN APO (49°N, 171°W) measured 54-kn winds and 30-ft seas. The PRESIDENT HOOVER (54°N, 165°W) measured 50-kn winds 21-ft seas. The report from the TOYOTA MARU No. 16 at 47°N, 175°W read 60-kn winds but the wind direction was off by 120° both according to the analysis and the direction of the swell waves.

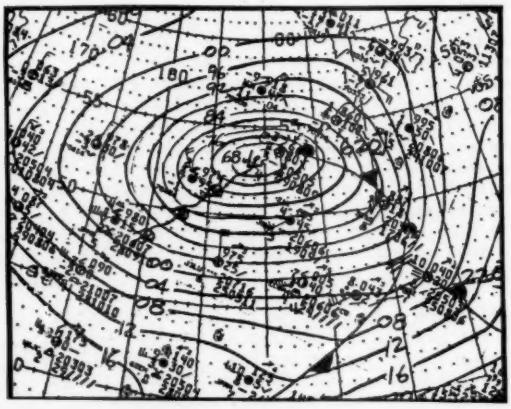


Figure 44.-- The 0000, April 16 chart shows a 968 mb LOW.

On the 17th the storm was over the Gulf of Alaska. The ALASKA MARU (54°N, 158°W) measured 52-kn west winds, 12-ft seas, and 33-ft swells. The GOLDEN HAWK (54°N, 149°W) measured 40-kn, 15-ft seas, and 28-ft swells. Buoy 46003 measured 26-ft seas. The CHEVRON CALIFORNIA (53°N, 149°W) had 50-kn winds, 10-ft seas, and 25-ft swells on the 18th. The PAPYRUS MARU (50°N, 145°W) had 33-ft swells. The storm broke up on the coast on the 18th.

On the 13th and 14th an area of weak pressure gradient existed over Japan and China. By the 14th a LOW had formed south of Shikoku, Japan. On the 15th it started moving eastward and a front formed in the circulation. There were a few gale reports on the 17th and 18th. At 0000 on the 18th the storm was 978 mb near 44°N, 165°E. The MACASSAR MARU (39°N, 161°E) had 45-kn winds and 15-ft swells. On the 19th, the PRESIDENT HOOVER (49°N, 164°E) measured 38-kn winds from the northwest. A Japanese ship (50°N, 172°W) measured 45-kn southwest winds and 20-ft swells on the 20th. By 0000 on the 21st the storm was over the Gulf of Alaska. The GREAT OCEAN (57°N, 143°W) measured 43-kn southeast winds and 21-st waves. The storm weakened as it approached the Alaska coast. At 2100 on the 22d the QUEEN OF PRINCE RUPERT at 54°N, 131°W found 41-kn south winds but reported no waves.

The GARZA STAR with a cargo of logs from Tacoma to Japan sent a distress message at 0500 on the 23d, while about 690 mi west of Vancouver Island, that the crew was abandoning ship (fig. 45). The logs shifted in 30-kn winds and 10-ft waves. All 23 crewmen were rescued by the EUROPEAN VENTURE.

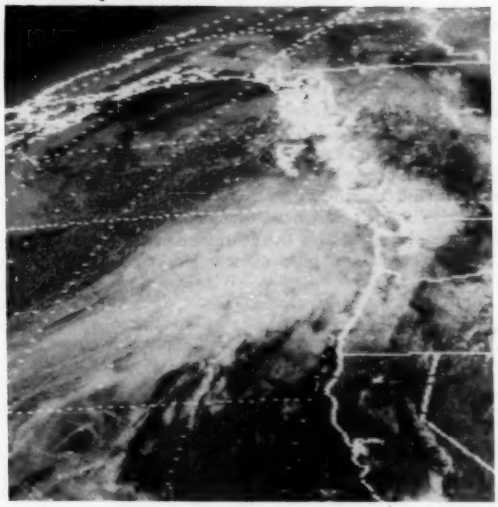


Figure 45.-- The storm that struck the GRAZA STAR' as it appeared at 1700, April 22. NOAA image.

Early in the last week of April the midlatitudes (approximately 30°N to 50°N) were dominated by high pressure. A wave formed near 32°N, 176°E on a weak front. By the 24th there were two primary high pressure centers, one at 1036 mb near 53°N, 168°E and another at 1038 mb near 41°N, 143°W. The frontal wave was moving northeastward between the two HIGHs. The TOYOTA MARU #24 (39°N, 179°W) northwesd of the storms center measured 57-kn winds from the north, 13-ft seas, and 23-ft swells. The SILVER ACE (39°N, 177°W) measured 49-kn winds from 030°, 25-ft seas and 26-ft swells from 060°. By 0000 on the 25th the storm had raced to 49°N, 157°W at 1000 mb.

The two HIGHs were now both 1040 mb near 48°N, 172°E and 40°N, 138°W. A Japanese ship at 39°N, 172°W measured 42-kn north winds, 17-ft seas, and 35-ft swells. On the 26th the storm was 984 mb near 54°N, 140°W. The CHEVRON MISSISSIPPI at 56°N, 140°W measured 42-kn winds from 070°, 7-ft seas, and 20-ft swells. A second center had formed near Kodiak Island as the original moved ashore on the 27th. This new center continued the circulation over the Gulf of Alaska but the winds were less than gale force.

Casualties -- There were two reported collisions in fog this month. The WONGUNHAE-HO collided head-on with the PAN JIN HAI in the Yellow Sea on the 18th. All 12 crewmen from the WONGUNHAE-HO were missing when the vessel sank. The KYOKUHO MARU No. 3 and the SASANO MARU No. 11 collided in fog on the 24th near 35°N, 130°E. The KYOKUHO MARU sank but the four crew members were rescued by the SASANO.

The ALBERNI DAWN and HYNDAI No. 21 dragged anchor in strong winds. The MICHALIS LEMOS reported heavy weather damage. The SHOKO MARU No. 38 listed in heavy weather off Fukuoka on the 12th and sank. Two crew were rescued and two missing.

Other Casualties -- The tug DE PING towing the MELBOURNE took refugee into Brisbane after damaging her towing gear in high winds and heavy seas. The ISLA SANTAY sustained hull damage when deck cargo went adrift in heavy weather off the Strait of Magellan.

WEATHER LOG, MAY 1985 -- The tracks of the centers of the cyclones were concentrated primarily between latitudes 45°N and 60°N except for the climatic area of cyclogensis east of Japan. There was an odd storm that formed north of Hawaii and tracked into the Gulf of Alaska. There was a primary storm path from near Tokyo to 47°N, 170°E. Another primary path extended from 45°N, 175°E into the eastern Bering Sea and north to the Bering Strait. The storms that entered the Gulf of Alaska were dispersed. The paths were reasonably close to climatology except for the one north through the Bering Sea to the Bering Strait.

The mean sea-level pressure pattern for the month featured a 1006 mb Aleutian Low near 57°N, 178°W (fig. 46). There was a second

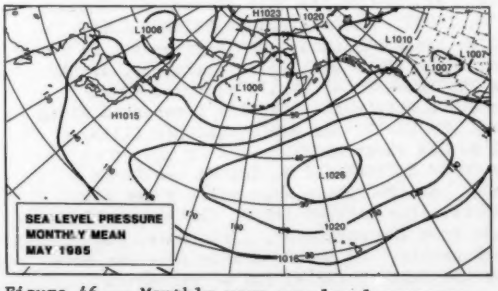


Figure 46.-- Monthly mean sea-level pressure.

1006 mb Low west of Sakhalin Island. The Pacific High was the largest feature with a central pressure of 1026 mb near 35°N, 159°W. The major departure from climatology was a single Aleutian Low instead of three centers across the southern Bering Sea.

The anomaly chart featured two primary centers, a minus 6 mb over the Bering Strait and plus 4 mb near 40°N, 160°W.

The upper-air flow at 700 mb was very near a carbon copy of the climatic normal. There was a Low over the Anadyrskiy Gulf. The long-wave trough was shifted to east of Japan rather than west. The ridge over the Rocky Mountains was near normal as was the trough off the California Coast.

Typhoon Gay formed this month.

Some Climatology. On May 18, 1980 Mount Saint Helens erupted in Washington State and spewed ash and smoke 63,000 ft into the air.

Extratropical Cyclones -- The month began with three high-pressure centers across the midlatitudes and two cyclones along the higher latitudes. By, midweek the Pacific High had moved northward and intensified to 1032 mb. The LOWs were now weak. This changed as a strong LOW formed over the central ocean between two HIGHs. Blocked by the Pacific High the LOW Moved northward. At the end of the week (7th) another LOW developed north of Hokkaido.

The second week this new LOW Moved into the circulation of the previous significant LOW and formed a large cyclone centered over the Bering Sea. The Pacific High still blocked eatward movement. By midweek all pressure systems were weak except for the Pacific High. At the end of the week the Pacific High had moved eastward and a strong LOW was able to enter the Gulf of Alaska. Another strong HIGH had moved into and developed over the midocean.

The Pacific High continued to move northeastward to British Columbia the third week. The HIGH over the central ocean was now 1042 mb and moving southeastward. A large LOW developed north of Hokkaido and tracked into the Bering Sea. At midweek there was high pressure along approximately latitude 35°N from coast to coast. A LOW formed in an easterly wave north of Hawaii. Tropical storm Gay formed the end of the week.

As the fourth week began there were multiple weak pressure centers except for Gay. By midweek the various centers had combined into a large cyclone and strong Pacific High. By the end of the month the LOW was moving along the Aleutians.

This cyclone almost burst into being on the 1800 chart of the 4th near 42°N, 166°E on a cold front separating two HIGHs. At 0000 on the 5th there were gales and the PACIFIC HIGHWAY (40°N, 160°E) had 44-kn north winds. At 0000 on the 6th the storm was 972 mb near Adak. The PACMERCHANT (54°N, 170°W) measured 60-kn southeast winds, 17-ft seas, and 23-ft swells. Later in the day the USCGC SHERMAN

(57°N, 172°Wj) measured 50-kn winds and 26-ft swells. The PACMERCHANT had 50-kn winds, 15-ft seas, and 26-ft swells on the 7th. A ship at 54°N, 166°W reported 40-kn winds, 13-ft seas and 33-ft swells. Mys Navarin measured 45-kn winds with heavy snow. By 0000 on the 8th another LOW had absorbed this one.

This was the LOW that absorbed the one above. On the 5th it was over the southern Sea of Okhotsk. By 0000 on the 7th it had rushed to 49°N, 174°E at 982 mb. The SHOSHUN MARU (47°N, 176°E) had 36-kn west winds, 10-ft seas, and 26-ft swells. The LUCENT STAR (47°N, 165°E) had 41-kn winds and 20-ft swells. By 0000 on the 8th the storm was 972 mb near 58°N, 173°W. There were several reports of winds near 50 kn and waves near 30 ft. The PACMERCHANT was now at 53°N, 178°W and measured 55-kn west winds, 15-ft seas, and 28-ft swells. The FENGTIEN (54°N, 175°W) quoted 50-kn winds, 17-ft seas, and 33-ft swells. On the 9th the storm was 981 mb and weakening. The ANSGARITOR (54°N, 164°W) had 52-kn winds and 28-ft waves on the 8th and 40-kn winds and 30-ft waves on the 9th at 54°N, 167°W. The storm was quasistationary over the Bering Strait the 9th and 10th.

A frontal wave formed on the coast of Honshu northeast of Tokyo on the 6th. It moved eastward and then northeastward relatively slowly over the Kuroshio Current and increased in size and intensity. On the 9th the storm was near 44°N, 162°E at 996 mb. There were a few gale reports in the southern part of the circulation. A Japanese ship near 38°N, 167°E reported 20-ft swells. By 1200 on the 9th another LOW formed at the point of occulsion and sped off to the northeast weaking the overall circulation. On the 12d the EVER VIGOR (43°N, 158°W) was 400 mi south of the center with 41-kn west winds, 17-ft seas, and 21-ft swells.

At 0000 on the 13th the storm was over the Gulf of Alaska near 56°N, 141°W at 986 mb. The MOBIL MERIDIAN (49°N, 127°W) reported 55-kn southeast winds, 20-ft seas, and 13-ft swells. The GALVESTON (50°N, 128°W) was not far away with 40-kn winds, 12-ft seas, and 20-ft swells. The storm dissipated over southern Alaska on the 14th.

As a LOW tracked eastward from the Kurile Islands it weakened and on the 13th another LOW formed about 300 mi to the south. This was in better alinement with the upper-air center. By 0000 on the 14th it was 976 mb near 50°N, 160°W. At 0500 the REGINA MAERSK took a special observation of 52-kn winds and 33-ft waves near 48°N, 156°W. The SEA-LAND EXPLORER (97°N, 156°W) measured 50-kn west winds, 13-ft seas, and 20-ft swells. On the 15th the storm was over the Gulf of Alaska. The GALAXY (58°,N, 141°W) found 55-kn southeast winds with only 16-ft waves. Other ships were reporting 35- to 45-kn winds. The highest waves were 23 ft by a SHIP near 51°N, 145°W. The storm was gone from the analysis on the 16th.

Another storm that formed off Honshu, Japan. It was first found on the analysis of 1800 on May 14. By 0000 on the 16th the storm was 988 mb near 47°N, 158°W. A few gales were being reported. On the 17th the storm was over the Bering Sea east of Ostrov Beringa. The JAPAN ALLIANCE (52°N, 169°E) measured 46-kn winds from 290° with 10-ft seas, and 33-ft swells. The NORDPOL (46°N, 152°W) found 50-kn winds and 20-ft seas.

On the 18th her winds were 41-kn with 20-ft seas. The storm passed through the Bering Strait later in the day and continued over the North Slope of Alaska.

An upper-air LOW was cut off from the main zonal circulation on the 17th and moved south towards Hawaii. A surface LOW formed on the 18th. At 0000 on the 19th it was 999 mb near 32°N, 150°W. The FORT DUFFERIN (39°N, 151°W) had 40-kn northeast winds and 15-ft seas. At 1800 the PACIFIC VICTORY had 51-kn north winds and 20-ft seas near 36°N, 151°W. On the 20th her winds had decreased to 38 kn but the seas were still 20 ft (fig. 47). The HANJIN KUNSAN (38°N, 145°W) had 46-kn east-northeast winds and 15-ft waves. On the 21st the storm as 996 mb near 37°N, 144°W but no reports of gale-force or higher winds. The storm turned northward on the 22d and dissipated on the 24th near Sitka.

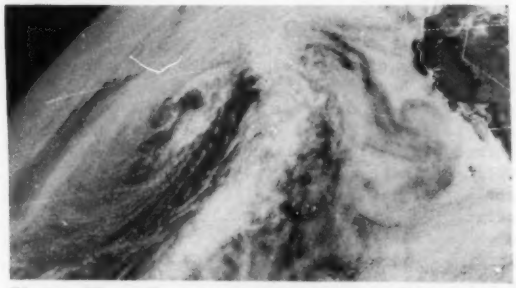


Figure 47.-- The storm near the edge of the World. Fog and low stratus along the Coast. NOAA image.

Although this storm formed in May it did not become important until several days into June over the Gulf of Alaska. Again the frontal wave formed east of Honshu, on the 29th this time. At 1200 on the 30th it was 984 mb near 40°N, 160°E. The CALIFORNIA RAINBOW (36°N, 155°E) had 45-kn winds and 16-ft seas. On June 1 the storm was 976 mb near 47°N, 177°W. The TOHOKU MARU (45°N, 177°W) found 40-kn winds. A ship near 40°N, 179°E reported 21-ft seas. On the 2d the SOHIO RESOLUTE (43°N, 152°W) had 35-kn winds.
The CO-OP EXPRESS (42°N, 161°W) had 40-kn winds. At 1800 there were quite a few gale reports. The LAKENES (46°N, 158°W) had 35-kn winds from the northwest, 13-ft seas, and 26-ft swells. On the 3d a ship that may have been the SALLY I (52°N, 136°W) had 40-kn

southeast winds, 25-ft seas, and 33-ft swells. There were still some gales and a report of 20-ft waves on the 4th. The storm remained a weak quasistationary circulation near 55°N, 150° until the 7th.

Casualties — The seas were rather tranquil with few weather casualties. The CHING HO No. 6 grounded at Espiritu Santo on the 6th in strong winds and poor visibility. The SEASPAN 479 grounded then broke adrift on the 3d in strong winds. The YAE MARU No. 37 and RABOCHAYA SMENA collided in heavy fog on the 13th near 42°N, 141°E. The YAE MARU sank and all nine fishermen were saved by the RABOCHAYA.

The FENGTIEN suffered heavy weather damage the 3d-8th enroute to Onahama from Port Angeles. The POSEIDON had engine trouble and was being towed by the MARANON but the tow line broke 3 times in 10 days and MARANON gave up towing due to a typhoon. A tug towed the vessel to Osaka.

Three Japanese fishermen were found alive, on the 10th, on Sakhalin Island after 16 days in a rubber lifeboat. Two dead companions were also in the lifeboat. The NITTO MARU No. 71 sank on April 23 and all hope had been given up of finding any of the 16 crew alive after four bodies and wreckage were spotted.

WEATHER LOG, JUNE 1985 — There were few significant extratropical cyclones this month. An anyone sailing the North Pacific during the month would know there were many more insignificant LOWs and frontal waves present. These were weak cyclones that persisted for less than 36 hr. The tracks of the significant cyclones were widely scattered from 30°N northward over the western ocean to 35°N northward over the eastern ocean. There was a slightly concentrated path from east of Tokyo (34°N, 155°E) east-northeastward to 40°N, 155°W. Two storms had almost identical tracks the first half of the month from 300 mi south of Adak into the northern Gulf of Alaska. The last week of the month two storms tracked into the Arctic Ocean from Siberia.

Over all the cyclones were weak as indicated by the monthly mean sea-level pressure chart (fig. 48). The primary feature of the month was the 1023 mb Pacific High centered near 40° N, 140°W, about 200 mi northeast of its normal position. A 1021 mb subcenter was near 38°N, 160°W. The Aleutian

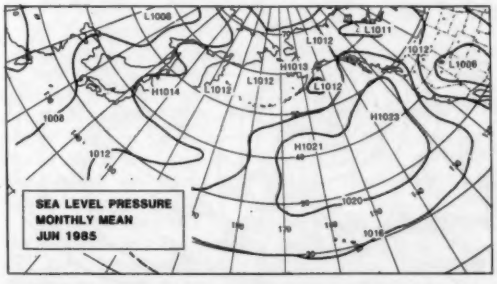


Figure 48.-- Monthly mean sea-level pressure.

Low was very weak with four 1012 mb Low centers, near 55°N, 155°W; 54°N, 178°W; 50°N, 162°E; and 65°N, 158°W. Intermixed was a 1013 mb High near 57°N, 167°W and a 1014 mb High near 42°N, 149°E. Climatology shows a 1010 mb Low about 100 mi north of Adak and 1011 mb Low near Mount McKinley.

The monthly mean sea-level pressure departure from normal chart had several weak anomaly centers. The greatest departure was plus 5 mb near 45°N, 168°W. There was a large positive area along the Asian Coast from Japan northward to the Arctic Ocean. The largest negative area was over the southwestern ocean with minus 4 mb centers over the South China Sea and Philippine Sea. Another minus 3 mb centers was near 37°N, 162°E.

There were three upper-air LOWs at 700 mb across the 50°N to 60°N latitude belt rather than the normal one. This produced a longer stretch of zonal winds across the midlatitudes than normal. The flow turned northward over the eastern Gulf of Alaska.

There were five tropical cyclones over the eastern North Pacific and two over the western North Pacific.

Extratropical Cyclones — The month began with a LOW over midocean that is described in the May Weather Log. A long banana-shaped HIGH paralleled latitude 30°N. At midweek another HIGH was over midocean north of the Pacific High, separated by an east-west front with minor waves. The end of the week produced many weak pressure systems.

The second week a cell of the Pacific High moved over the Gulf of Alaska. There were still many weak pressure cells. By midweek there was a line of large LOWs along the old front from south of Honshu to south of the Alaska Peninsula. The eastern LOW developed into a storm as it pushed into the Gulf of Alaska as the HIGH moved inland. By the end of the week the LOW had dissipated and high pressure was the main feature over the North Pacific Basin.

As the third week started there were two developing LOWs imbedded in the mainly high pressure. Both tracked northeastward and became large storms but not severe. By the end of the week both LOWs were gone and high pressure prevailed over the eastern two-thirds of the basin. Typhoon Hal was over the Philippine Sea.

The fourth week the Pacific High was a large 1036 mb system near 44°N, 160°W. At midweek it had drifted to 45°N, 150°W at 1042 mb. West of longitude 180° there were small weak pressure cells. Late in the week a LOW tracked into the Gulf of Alaska and another LOW tracked northward toward the Bering Sea. The Pacific High blocked the western LOW and it slowly weakened. The end of the month there were only two significant systems, typhoon Irma and the Pacific High.

This was one of the frontal waves on the east-west front between two high pressure areas. This one was identified early on the

7th southeast of Tokyo. At 0000 on the 8th the LOW was 998 mb near 34°N, 155°E. The AFRICAN HIGHWAY (35°N, 153°E) had 40-kn northwest winds. On the 9th several ships reported gales. The TSUSHIMA (40°N, 167°E) measured 42-kn east winds, 17-ft seas, and 21-ft swells. On the 10th her winds were 39-kn and the highest swell 16 ft. The storm weakened but continued eastward and died off Portland on the 13th.

This LOW formed south of Adak Island on the 8th. The TAO YUAN (48°N, 162°W) had southeast 38-kn winds and 13-ft seas. By 0000 on the 10th the storm had a large circulation around a 987-mb center near 48°N, 157°W. The CHEVRON MISSISSIPPI (51°N, 151°W) had 45-kn winds from the east but only 10-ft seas. The GOLDEN ORCHID (45°N, 168°W) found 26-ft seas an 23-ft swells. At 1800 the CHEVRON COLORADO (55°N, 146°W) had 47-kn east winds 21-ft seas, an 23-ft swells. On the 11th the storm was 987 mb near 53°W, 151°W. A Chinese ship near 45°N, 145°W had 25-ft seas, and 21-ft swells. The storm weakened rapidly on the 12th and remained quasi-stationary near 57°N, 145°W until the 16th.

On the 15th two cells of the Pacific High were pushing against the North American Coast. The southern cell was causing a tight gradient with the heat LOW over California. The PRESIDENT WASHINGTON (39°N, 125°W) measured 45-kn northwest winds, 13-ft seas, and 23-ft swells. The GOLDEN ORCHID (35°N, 123°W) measured 48-kn winds from the northwest, 17-ft seas, and 20-ft swells. The gradient relaxed on the 16th as the southern high-pressure cell combined with the northern one.

The 0000 chart of the 13th first showed this frontal wave. A wind observation of 10 kn from the northeast from the JLRQ and a 25-kn south wind observation from the JQHP helped identify its formation. The frontal wave moved rapidly eastward under upper-air zonal flow until the 15th when it turned northeastward. At 0000 on the 16th the storm was 996 mb near 41°N, 153°W. The EVER VITAL (48°N, 144°W) had 36-kn southeast winds. At 0000 on the 17th the storm was 992 mb near 47°N, 146°W (fig. 49). The OREGON BRIDGE (41°N, 149°W) had 40-kn north winds and 15-ft waves. Several other ships reported gales. The OVERSEAS JUNEAU (55°N, 139°W) had 37-kn winds from the southeast and 20-ft seas. Later in the day the storm started weakening.

This cyclone was a consolidation of two small LOWs so it was full blown at birth on the 16th. The AFRICA MARU (49°N, 176°E) had 39-kn east winds. At 0000 on the 17th the storm was 988 mb near 50°N, 178°W. Several ships had gales. The DE STEIGUER (53°N, 175°W) had east winds at 38 kn and 30-ft seas. Six hours later the seas were 20-ft. The storm was 986 mb at 0000 on the 18th. The CHIKURA MARU (54°N, 176°W) had 49-kn northeast winds. On the 19th the NEW YELLOW SEA (50°N, 149°W) found 49-kn winds from the southeast. The storm weakened as it crossed the Aleutians into Bristol Bay.

Casualties -- The Pacific lived up to its name this month. The KINSEI MARU and ALAIN L.D. collided in poor visibilityion the 16th off Mutsure. The KIYOSHI MARU grounded in dense fog on the 25th near Okayama.

The PEARL KIM encounted heavy weather between the 6th and 9th and suffered damage. The RIVER GURARA had damage in heavy weather at Keelung.

Other Casualties -- The South Pacific and Indian Ocean was not so calm. The Soviet reserch vessel MIKHAIL SOMOV was trapped in thick ice off Antarctica in early June. Her problems started in March when a storm caused a build up in ice. The icebreaker VLADIVOSTOK sailed on June 8 to her assistance and arrived July 26. The two vessels cleared the ice field on August 11.

These vessels had heavy weather near Australia: DILKARA, KARINGAL, and RESOLUTION BAY.

The ORCHID XI, MIGHTY SERVANT 2, NITYA AMAR, and MARATHA TRANSHIPPER had weather problems in the Indian Ocean.

The YOUNG KWANG No. 1 stranded on the 22d at Aunun Island (40°S, 171°W) in winds and bad visibility.

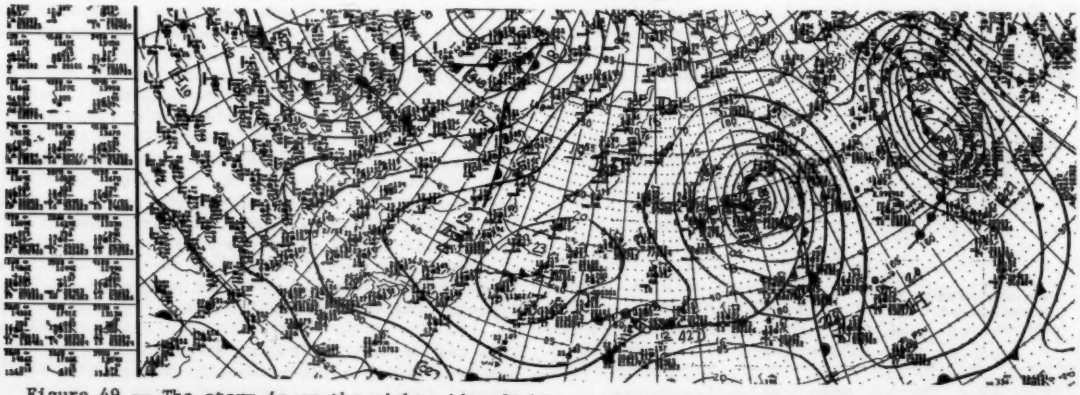


Figure 49.-- The storm is on the right side of this section of the weather chart. On the left side are plotted observations that could not be plotted on the chart itself, and are used by the analyst and forecaster.

Hurricane Alley

Dick DeAngelis
National Oceanographic Data Center
Washington, D.C.

The tropical cyclone summaries and tracks (fig. 50) are based upon information provided by people from several tropical meteorological centers. These include Ted Tsui of the Naval Environmental Prediction Research Facility; Emil Gunther of the Eastern North Pacific Hurricane Center and Gordon J. Bell, Director of the Royal Observator, Hong Kong. Their assistance is invaluable. The Eastern and Western North Pacific tracks can be considered as final (except for typhoon Hal). The others are preliminary although most have been analyzed. Table 10 lists the the tropical cyclones that have developed so far in 1985.

TROPICAL CYCLONES--APRIL 1985

This is ususally the least active month of the year with an average of three tropical cyclones of which one or two reach hurricane strength. This year was right on track with hurricanes Helisaonina and Margot and tropical storm Gretel. All three developed in the Southern Hemisphere between the 10th and 12th, from just south of Diego Garcia to Cape Wessel (Northern Australia).

Helisaonina was the most intense with estimated maximum winds climbing to 110 kn on the 14th. After reacting with a mid-latitude frontal system to the south, the hurricane turned an anticyclonic loop. However the entrainment of cooler air from this sytem inhibited the convecton and Helisaonina began to weaken as it headed toward the west-northwest. Meanwhile both Margot and Gretel had formed. Margot took a southwesterly track toward the North West Cape while Gretel moved through the Clarence Strait and over Darwin. According to local press reports winds at Darwin gusted to 65 kn; sustained winds near the storm's center were estimated at 40 kn on the 13th. An entire fleet of 10 fishing vessels broke their moorings during the storm and were driven ashore or onto a wharf. All were recovered the following day. Margot, whose winds had climbed to 70 kn on the 14th, weakened as she approached Northwestern Australia. She slowed and turned northward on the 17th.

TROPICAL CYCLONES--MAY 1985

Another three tropical cyclones developed in May with just one -- Gay reaching hurricane intensity. This is close to normal. The two tropical storms formed in the Indian Ocean while typhoon Gay came to life in the western North Pacific. 01B which devastated Bangladesh was described in the Summer 1985 issue on page 141.

Typhoon Gay was the first in a series of three typhoons to develop in the Philippine Sea in a 5-week period; Hal and Irma formed in June. Gay was first detected on the 20th; 2 days later 01B popped up in the Bay of Bengal and on the 27th 02A came to life in the Arabian Sea. All of these storms traversed a northerly path and the two Indian Ocean storms made landfall within 4 days and before they could reach hurricane intensity. Gay, with more sea room, became a typhoon early on the 23d and remained one through the 25th. Her maximum winds reached 100 kn on the 24th.

The Arabian Sea storm while not as devastating as the Bangledesh Cyclone created some flooding problems from Cochin to Karachi. At sea the drilling platform SAGAR PRAGATI had the tow from a tug part off the coast some 70-mi from Bombay. Seas in the area were 15 ft. On the 31st the storm moved ashore near Mandri.

TROPICAL CYCLONES--JUNE 1985

Six cyclones developed in the tropics and four of these reached typhoon or hurricane intensity. This activity was more than normal thanks to the flurry in the eastern North Pacific, where two hurricanes and two tropical storms came to life; two typhoons were spawned in the western North Pacific.

In rapid succession Andres, Blanca and Carlos blossomed over the eastern North Pacific. Blanca was the longest lived and was a hurricane from the 8th through the 15th. Her maximum winds were estimated at more than 100 kn from 0600 on the 13th to 0600 on the 14th; they reached a peak of 105 kn at 0000 on the 14th. Andres nearly reached hurricane strength when his winds climbed to 60 kn on the 7th, but then began to weaken before the day was through. Carlos was only a short-lived minimal tropical storm that flared up briefly near 120°W.

Typhoon Hal debuted on the 18th. Moving west-northwestward he intensified to typhoon strength on the 21st about 360 mi east-northeast of Manila. Recommaissance air craft reported 80-kn winds and a 964-mb center. The eye was some 80 mi in diameter. The typhoon accelerated and passed about 35 mi north of Luzon early on the 22d. In the central and northern Philippines about 50 people were killed and 2000 were left homeless. In Manilla Bay the MAGALLANES, SEA QUEST, ARLUNYA and ARINYA ran aground while the SULPICIO and CONTAINER IV were aground in Canigao Channel and the DENNIS CARRIER was driven aground in Mariveles harbor. The MONARCH, laid up in Manila Bay, dragged her anchor and was driven aground in the entrance to Pasig River. Damage in the Philippines was estimated, initially, at $4 million.

Hal passed 170 mi southwest of Lan Yu, Taiwan where sustained winds of 48 kn and a 994.1-mb pressure were reported. In Taiwan 2 people were killed, 5 were missing and 18 others injured. On the 23d the CHEVALIER ROZE reported 55-kn winds and a 988.5-mb pressure about 110 mi south of the center. During the

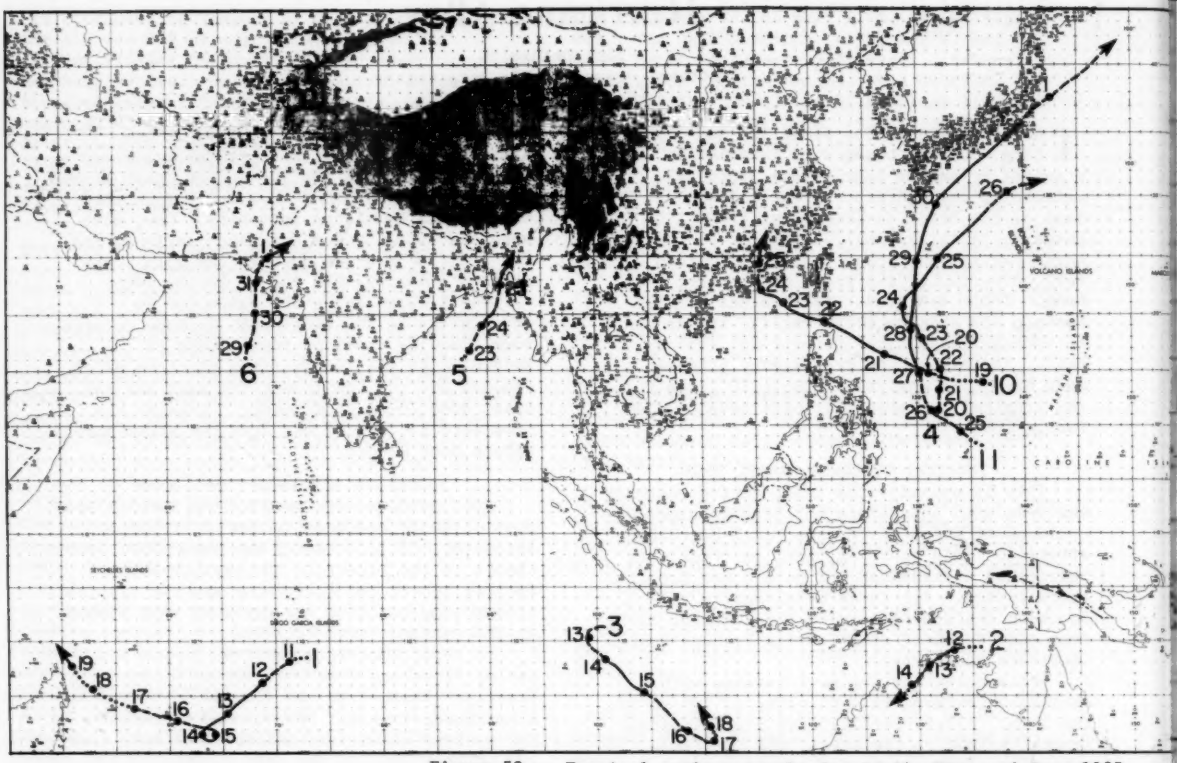


Figure 50.-- Tropical cyclone tracks for April, May, and June 1985.

afternoon Hal passed about 40 mi north of Dongsha where the pressure fell to 974.6 mb and sustained winds climbed to 54 kn. Hal crossed the China coast during the afternoon of the 24th and weakened to tropical storm strength by evening. In southern Guangdong 2 people were killed and nearly 40 thousand homes were damaged. A boat with a cargo fertilizer sank in Shanwei Bay but all 10 people aboard were rescued. In the Hong Kong area northwesterly winds reached gale force offshore on the 24th. A maximum hourly mean wind of 38 kn and a peak gust of 65 kn were recorded at Cheung Chau at about 3:00 pm (LST). The minimum sea-level pressure at the Royal Observatory was 985.5 mb recorded at 5:00 a.m. when Hal was about 80 mi to the east-southeast. Damage in Hong Kong was minor but an 18-yr old youth was missing when swimming in Big Wave Bay, Shek O on the 23d.

Irma developed in the Philippine Sea while Hal was dissipating over China. She reached typhoon strength on the 27th and winds climbed to 90 kn on the 29th as Irma approached Honshu. Irma raised havoc with shipping in the area. The HOKOKU MARU No. 3 ran aground twice but the crew were rescued. At Yokohama the LARA dragged anchor and collided with the HAN CHUAN. The WILLI had stowage of cargo collapse while on voyage from Sarawak to Tokyo laden with lauan logs, some of which were thrown overboard. The AVIOR ran aground in Tateyama Bay while the GLORIA FORTUNA was hard aground off Shirahama. The KYOEI MARU No. 12 collided with the TAKAZAWA MARU No. 5. Several other collisons took place near Yokohama. At Marita Airport, Tokyo an airplane hit by a wind gust smashed into a boarding bridge and cracked its nose.

The last two storms of the month formed in the Eastern Pacific. On the 26th, Dolores moving west-northwestward reached hurricane intensity by the 28th. By July 1 winds near her center had climbed to 100 kn. However after crossing the 20th parallel Dolores dropped to minimal hurricane strength and continued to weaken. Meanwhile to the west at about the same latitude Enrique came to life about one day later. However he only reached tropical storm strength, as maximum winds climed to 35 kn on the 29th. Unlike Dolores, Enrique turned westward and moved along the 15th parallel passing south of Hawaii as a tropical depression.

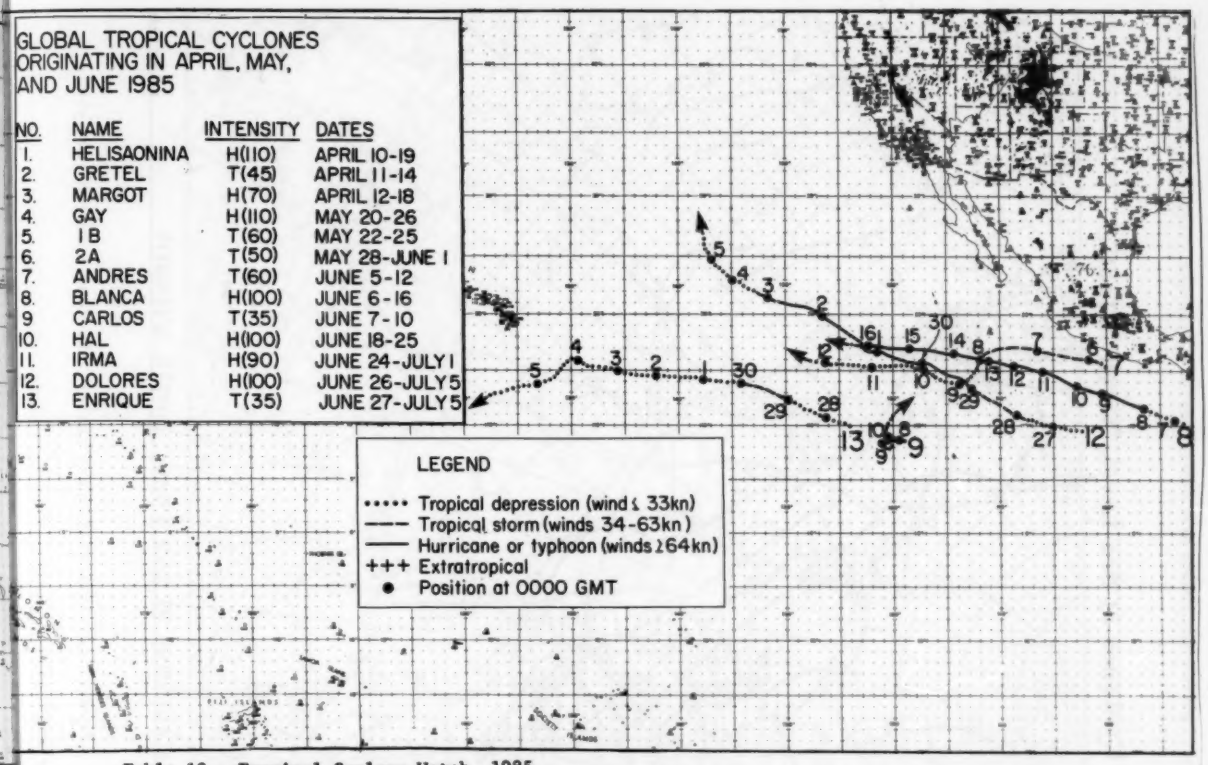

GLOBAL TROPICAL CYCLONES
ORIGINATING IN APRIL, MAY,
AND JUNE 1985
NO. NAME INTENSITY DATES
1. HELISAONINA H(110) APRIL 10-19
2. GRETEL T(45) APRIL 11-14
3. MARGOT H(70) APRIL 12-18
4. GAY H(110) MAY 20-26
5. 1B T(60) MAY 22-25
6. 2A T(50) MAY 28-JUNE 1
7. ANDRES T(60) JUNE 5-12
8. BLANCA H(100) JUNE 6-16
9 CARLOS T(35) JUNE 7-10
10. HAL H(100) JUNE 18-25
11. IRMA H(90) JUNE 24-JULY 1
12. DOLORES H(100) JUNE 26-JULY 5
13. ENRIQUE T(35) JUNE 27-JULY 5
LEGEND
Tropical depression (winds ≤ 33kn)
Tropical storm (winds 34-63kn)
Hurricane or typhoon (winds ≥64kn)
Extratropical
Position at 0000 GMT

Table 10.--Tropical Cyclone Watch, 1985

Eastern North Pacific

Andres	TD 1E T June
Blanca	TD 2E H June
Carlos	TD 3E T June
Dolores	TD 4E H June
Enrique	TD 5E T June
Fefa	TD 6E T July
Guillermo	TD 7E T July
Hilda	TD 9E T July
Ignacio	TD 11E H July
Jimean	TD 10E H July
Kevin	TD 12E T July
Linda	TD 13E T July
Marty	TD 14E H Aug.
Nora	TD 15E T Aug.
Olaf	TD 16E H Aug.
Pauline	TD 17E H Aug.
Rick	TD 18E H Sept.
Sandra	TD 19E H Sept.
Terry	TD 20E H Sept.
Vivian	TD 21E T Sept.
Waldo	TD 22E H Oct.
Xina	TD 23E H Oct.

North Atlantic Ocean

Anna	TD 1 T July
Bob	TD 2 H July
Claudette	TD 3 h Aug.
Danny	TD 4 H Aug.
Elena	TD 5 H Aug.
Fabian	TD 7 T Sept.
Gloria	TD 9 H Sept.
Henri	TD 10 T Sept.
Isabel	TD 11 T Oct.
Juan	TD 12 H Oct.
Kate	TD 13 H Nov.

Western North Pacific

Elsie	TD 1W T Jan.
Fabian	TD 2W T Jan.
Gay	TD 3W H May
Hal	TD 5W H June
Irma	TD 6W H June
Jeff	TD 7W H July
Kit	TD 8W T Aug.
Lee	TD 9W T Aug.
Mamie	TD 10W H Aug.
Nelson	TD 11W H Aug.
Odessa	TD 12W H Aug.
Pat	TD 13W H Aug.
Ruby	TD 14W T Aug.
Tess	TD 15W H Sept.
Val	TD 16W T Sept.
Winona	TD 17W T Sept.
Andy	TD 18W H Sept.
Brenda	TD 19W H Sept.
Cecil	TD 20W H Oct.
Dot	TD 21W H Oct.
Ellis	TD 22W T Oct.
Faye	TD 23W T Oct.

North Indian Ocean

--	1B T May
--	2A T May
--	03B T Oct.
--	04B T Oct.

Central North Pacific

Skip	TD 2C H Aug.
Nelle	TD 3C T Oct.

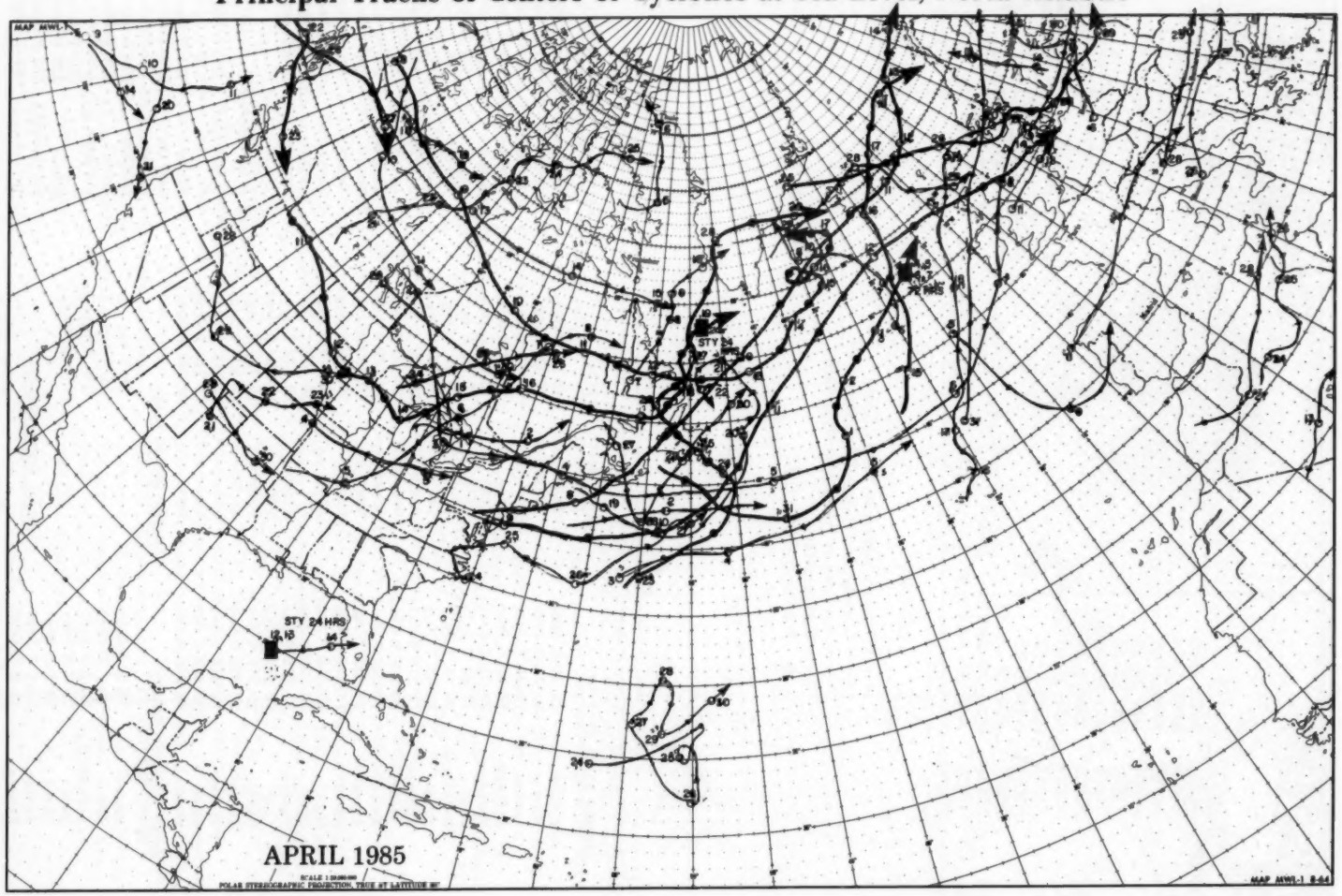
Australia - South Pacific

Drena	9P T Jan.
Eric	11P H Jan.
Nigel	13P H Jan.
Odette	14P H Jan.
Freda	16P H Jan.
--	18P T Feb.
Hubert	20S H Feb.
Jacob	25S H Feb.
Pierre	26S T Feb.
Gavin	27P T March
Lindsay	29S T March
Hina	30P H March
Sandy	31P H March
Tanya	32P H March
Gretel	34P T April
Margot	35S H April

South Indian Ocean

Celestina	10S T Jan.
--	12S T Jan.
Ditra	15S H Jan.
Gertie	17S T Jan.
Esitera	19S T Feb.
Feliksa	21S T Feb.
Isabel	22S T FEb.
Gerimena	23S H Feb.
--	24S T Feb.
Kristy	28S T March
Helisaonina	33S H April
--	01S T Sept.

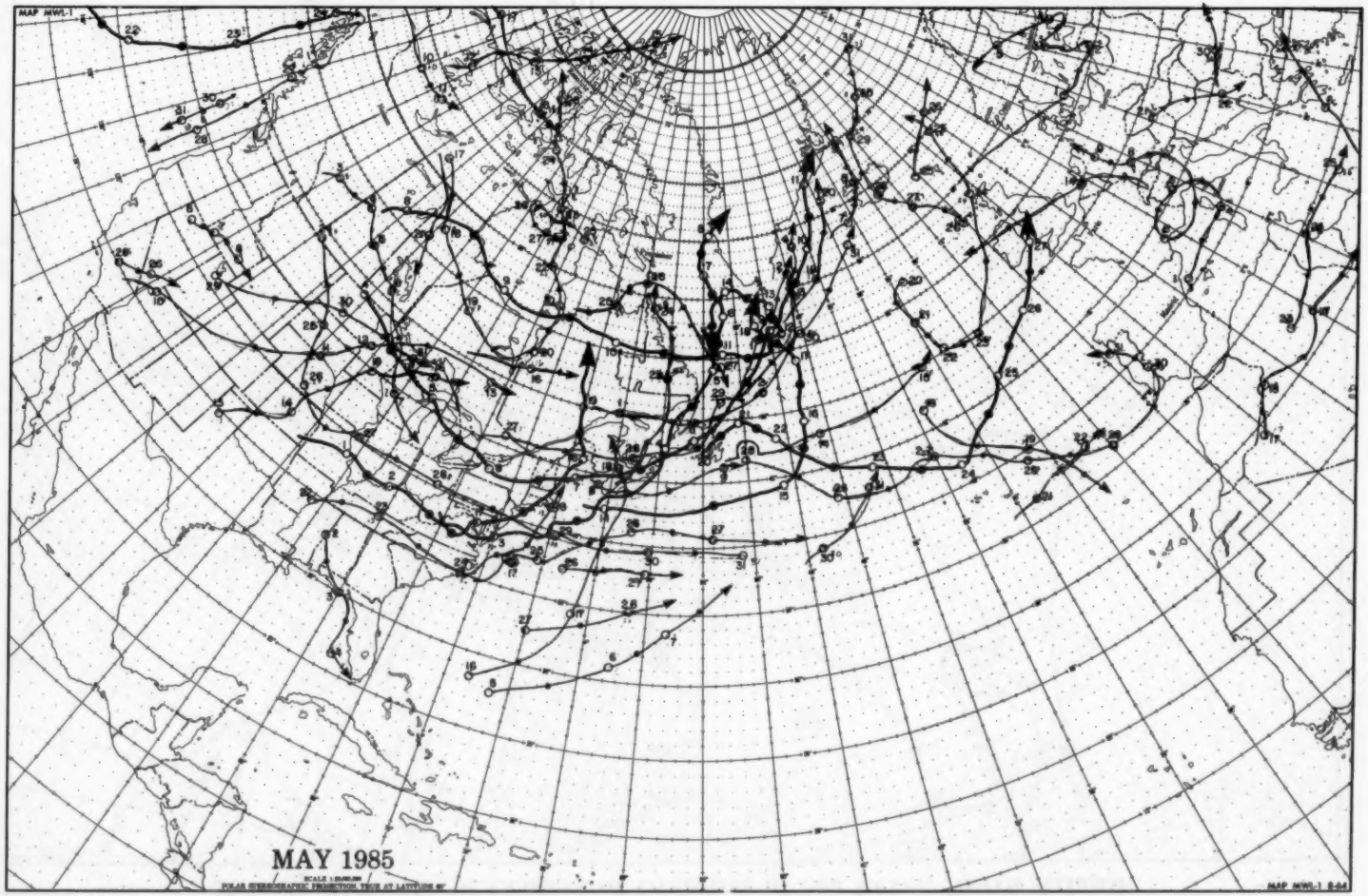
Principal Tracks of Centers of Cyclones at Sea Level, North Atlantic



Closed circle indicates 0000 and open circle 1200 GMT positions. Square indicates stationary center. Cyclone tracks marked with heavy line are described in the Weather Log.

Closed circle indicates 0000 and open circle 1200 GMT positions. Square indicates stationary center. Cyclone tracks marked with heavy line are described in the Weather Log.

Principal Tracks of Centers of Cyclones at Sea Level, North Atlantic



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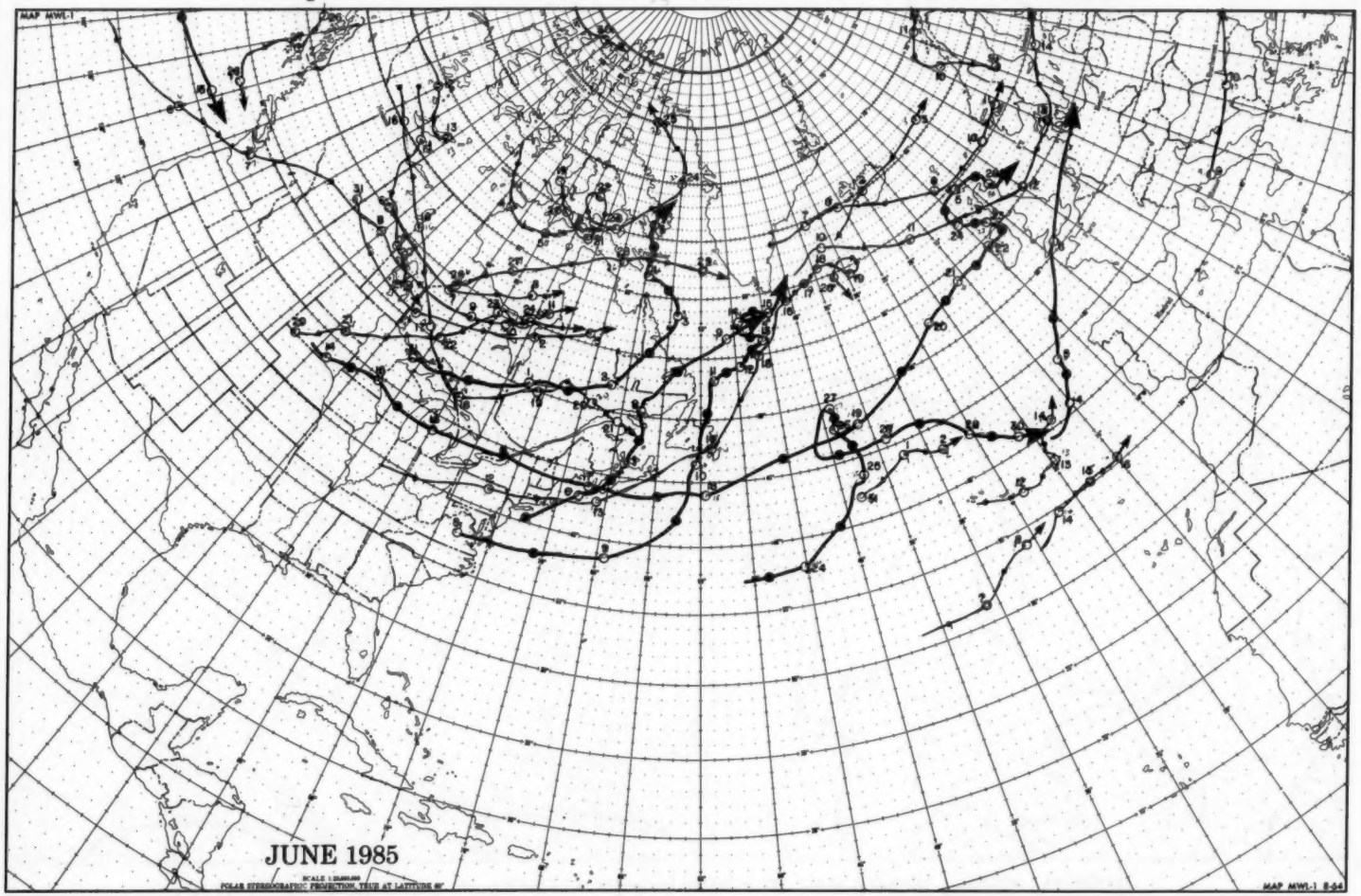
Principal Tracks of Centers of Cyclones at Sea Level, North Atlantic



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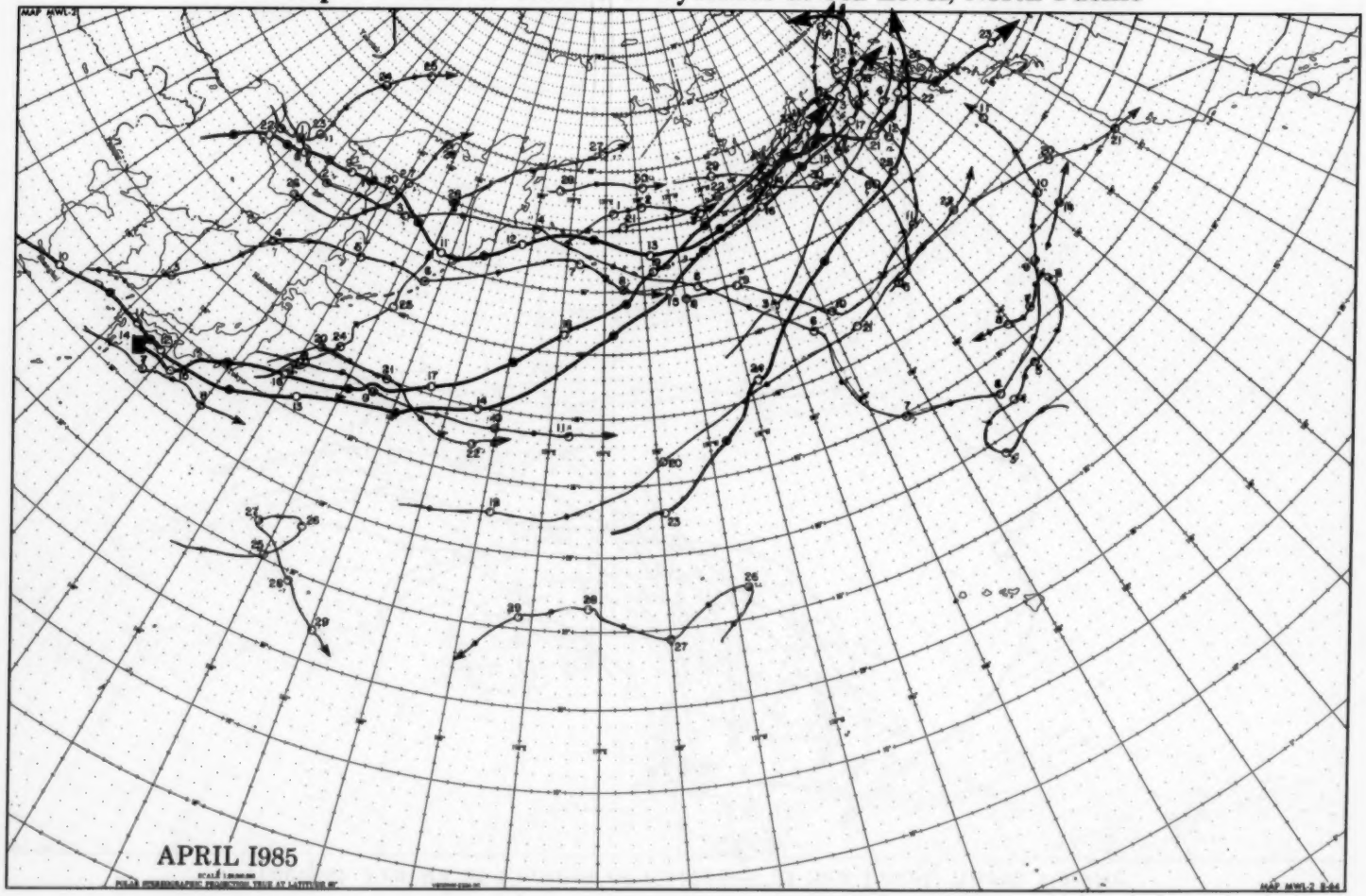
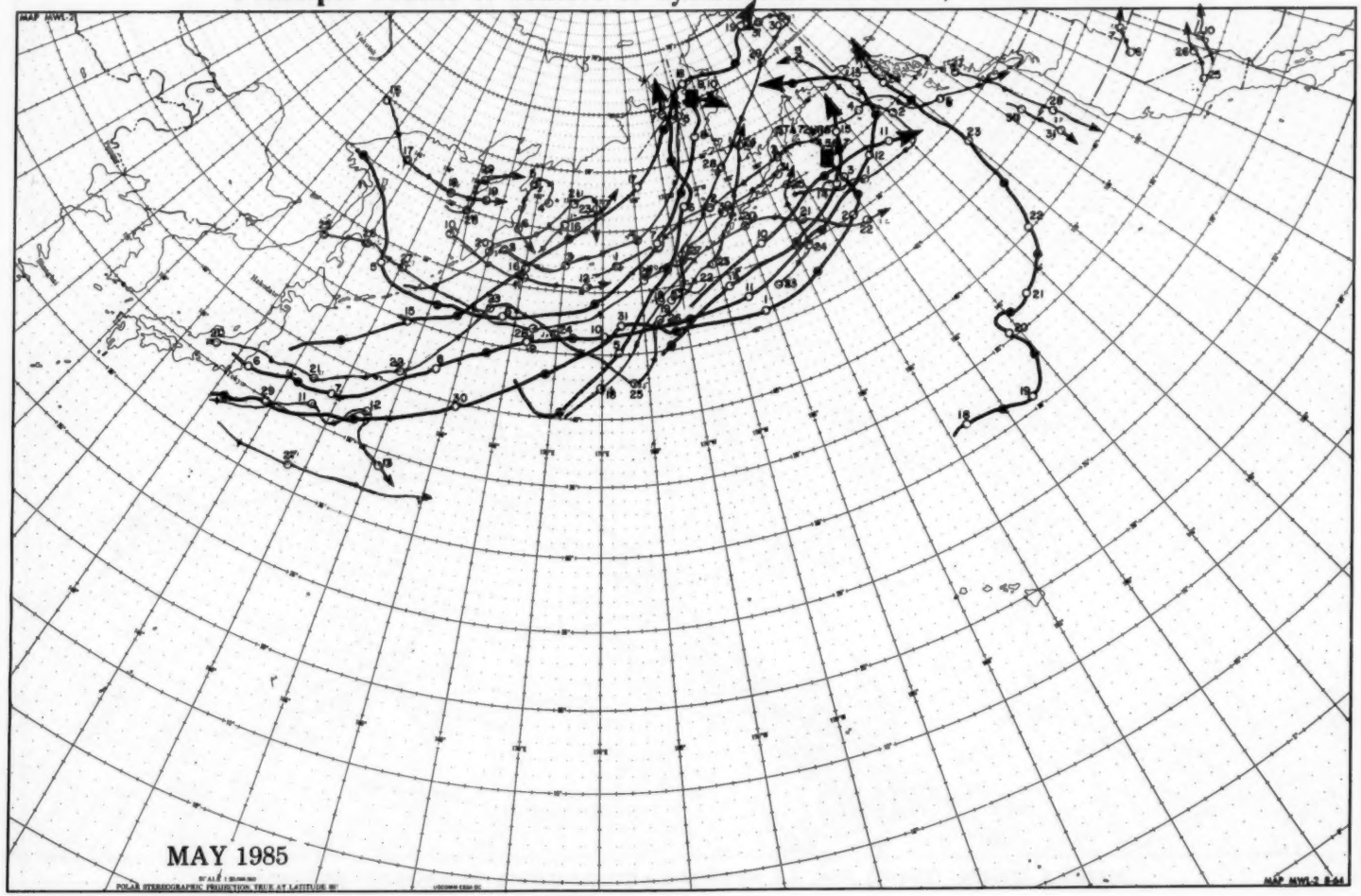
heavy line are described in the Weather Log.

Principal Tracks of Centers of Cyclones at Sea Level, North Pacific



Closed circle indicates 0000 and open circle 1200 GMT positions. Square indicates stationary center. Cyclone tracks marked with heavy line are described in the Weather Log.

Principal Tracks of Centers of Cyclones at Sea Level, North Pacific



Closed circle indicates 0000 and open circle 1200 GMT positions. Square indicates stationary center. Cyclone tracks marked with heavy line are described in the Weather Log.

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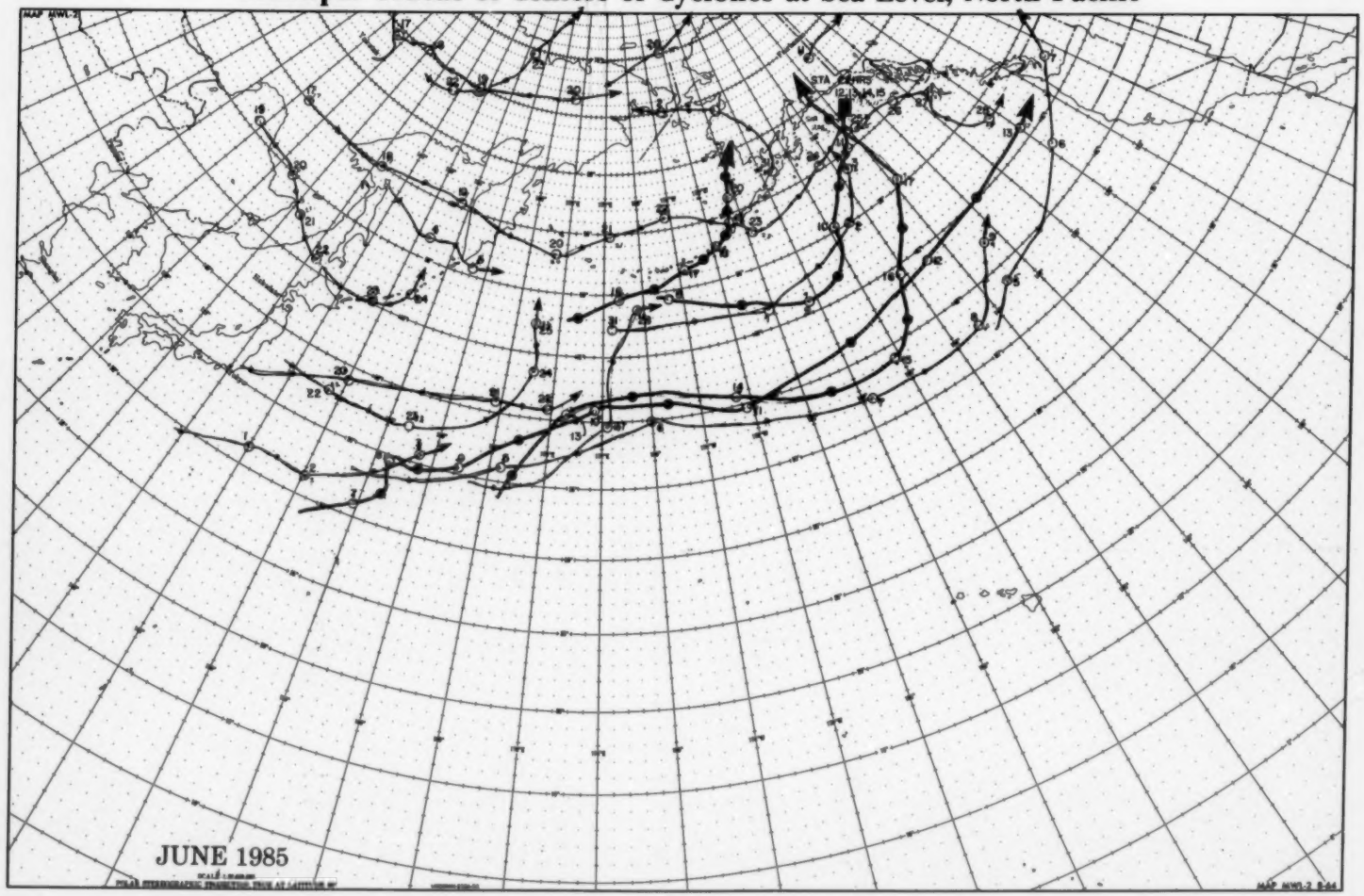
Principal Tracks of Centers of Cyclones at Sea Level, North Pacific



Closed circle indicates 0000 and open circle 1200 GMT positions. Square indicates stationary center. Cyclone tracks marked with heavy line are described in the Weather Log.

North Atlantic Selected Gale and Wave Observations

April, May and June 1985

Vessel	Nationality	Date	Position of Ship Lat. deg.	Position of Ship Long. deg.	Time GMT	Wind Dir. 10°	Wind Speed kt.	Visibility n. mi.	Present Weather code	Pressure mb.	Temperature °C Air	Temperature °C Sea	Sea Waves? Period sec.	Sea Waves? Height ft.	Swell Waves Dir. 10°	Swell Waves Period sec.*	Swell Waves Height ft.
	ATLANTIC	APR.															
SANKO AZALEA	3ELB3	1	39.2 N	42.3 W	00	30	M 53	2 NM	64	0982.0	9.0	17.0	8	26	27	11	31
HUAL TRAVELLER	LLRI	1	42.2 N	47.9 W	06	33	M 49			0993.3	5.5		6	13	31	6	19.5
MATHILDE MAERSK	OXKE	1	40.9 N	31.7 W	06	18	45	1 NM	65	0977.5	14.5		6	19.5			
ADM WM. M. CALLAGHAN	KGYE	1	41.7 N	45.0 W	18	31	50	5 NM	89	0995.0	5.0	13.4	6	19.5	31	8	34.5
SEALAND PRODUCER	WJRJ	2	42.3 N	44.8 W	00	32	55	2 NM	21	0998.0	4.4	12.8	10	19.5	30	8	16.5
SAMUEL M. ARMACOST	C6FA6	2	41.2 N	43.0 W	06	33	40	5 NM	00	0998.2	7.0		8	23			
SANKO AZALEA	3ELB3	2	39.7 N	32.5 W	12	28	M 44	5 NM	21	1000.0	11.5	15.0	6	16.5	31	10	26
SANKO AZALEA	3ELB3	3	40.4 N	29.4 W	00	26	M 45	10 NM	15	1005.7	12.0	15.0	6	16.5	29	9	24.5
AMERICAN PURITAN	KRGE	3	37.7 N	34.7 W	00	25	M 40	5 NM	02	1007.5	15.0	15.6	9	18	26	13	21
SANKO AZALEA	3ELB3	4	43.6 N	20.8 W	12	28	M 40	10 NM	15	1004.2	12.0	14.0	5	16.5	31	11	23
TFL EXPRESS	9VPU	4	45.2 N	24.7 W	12	29	M 44	5 NM		1001.6	13.5	14.5	10	23			
AMERICAN ENVOY	WPGK	6	41.1 N	27.5 W	18	28	52	5 NM	02	0997.0	15.0	12.8	4	13	28	12	32.5
DYUI SKAGERAK	DUVB	10	14.2 N	22.8 W	12	01	M 41	5 NM	03	1014.5	21.0	20.0	6	16.5	02	14	19.5
FETISH	OWIS	10	54.6 N	28.1 W	18	28	45	1 NM	26	1006.0	3.5		11	19.5			
FETISH	OWIS	11	54.5 N	28.7 W	00	28	50	1 NM	26	1011.0	4.0		11	29.5			
AMERICAN ENVOY	WPGK	11	40.9 N	57.3 W	00	26	40	10 NM	01	1013.6	6.7	12.8	3	6.5	25	4	19.5
DYUI SKAGERAK	DUVB	12	21.7 N	18.1 W	06	02	M 48			1020.0	17.0	19.0	6	24.5	02	14	29.5
USNS KANE TAGS 27	NZSK	13	47.5 N	20.0 W	00	29	M 42	5 NM		1022.5	9.4	11.1	3	16.5	29	8	19.5
DYUI SKAGERAK	DUVB	13	27.3 N	14.2 W	12	34	M 51	2 NM	05	1017.0	18.0	15.0	6	23	01	12	31
SANKO LAPIS	ELDW7	13	47.1 N	11.3 W	17	31	M 47	5 NM	00	1017.0	10.0		8	19.5			
AMERICAN PURITAN	KRGB	13	44.5 N	08.9 W	18	30	M 45	10 NM	15	1020.1	11.7	11.1	5	6.5	30	9	21
DYUI SKAGERAK	DUVB	14	30.0 N	11.8 W	06	02	M 51			1015.0	16.5	15.0	8	29.5	01	12	29.5
	ATLANTIC	MAY															
DYUI SKAGERAK	DUVB	14	39.9 N	45.6 W	18	22	M 44			1016.0	19.2	18.0	7	8	25	10	24.5
DYUI SKAGERAK	DUVB	15	39.2 N	51.6 W	18	30	M 61			1004.0	8.5	18.0	8	24.5	28	12	32.5
SEALAND LEADER	WSAH	16	41.0 N	48.7 W	00	31	M 40	5 NM	61	1003.5	6.0	16.0	5	11.5	31	10	19.5
DYUI SKAGERAK	DUVB	17	36.4 N	65.3 W	18	17	M 55	2 NM	25	0994.0	21.0	22.0	8	8	17	10	21
SUNSET PEAK	ZCNC	17	38.0 N	61.7 W	19	14	41	1 NM	81	1003.0	20.0	21.-	8	19.5	14	10	18
DYUI SKAGERAK	DUVB	18	35.8 N	66.8 W	00	20	M 60	2 NM	25	1000.0	21.0	22.0	8	10	20	10	21
	ATLANTIC	JUNE															
DYUI SKAGERAK	DUVB	5	45.5 N	23.0 W	18	03	M 55			1015.0	14.0	15.0	6	19.5	02	8	24.5
DYUI SKAGERAK	DUVB	18	40.5 N	41.5 W	12	20	M 44	5 NM	02	1017.0	20.0	19.0	4	16.5	20	8	19.5
SEALAND PRODUCER	WJRJ	21	46.4 N	17.9 W	12	31	47	10 NM	01	1009.5	13.9	11.7	7	13	30	10	19.5

+ Direction of sea waves same as wind direction
X Direction or period of waves indeterminate
M Measured wind

NOTE: The observations are selected from those with winds ≥ 40 kn or waves ≥ 20 ft from April through September and 45 kn or 30 ft October through March.

North Pacific Selected Gale and Wave Observations

April, May and June 1985

Vessel	Nationality	Date	Position of Ship Lat. deg.	Position of Ship Long. deg.	Time GMT	Wind Dir. 10°	Wind Speed kt.	Visibility n. mi.	Present Weather code	Pressure mb.	Temperature °C Air	Temperature °C Sea	Sea Waves? Period sec.	Sea Waves? Height ft.	Swell Waves Dir. 10°	Swell Waves Period sec.*	Swell Waves Height ft.
	PACIFIC	APR.															
HOTAKA MARU	JCZF	3	54.0 N	153.3 W	06	27	M 45			0999.5	4.0	5.0	8	13	28	10	19.5
APCO JUNEAU	KSBG	3	54.9 N	138.7 W	18	27	M 45	5 NM	50	1003.5	6.1	5.0	9	19.5	26	14	5
DIANA	YJHM?	4	55.0 N	140.0 W	11	25	M 40	.5 NM	24	1001.0	6.0	7.0	12	21	26	14	26
HOMSING BREEZE	3ECU	7	53.7 N	155.6 W	06	32	M 45	1 NM	56	1000.5	2.0	5.0	2	13	32	9	21
ZEPHUNTER	S6CK	8	31.9 N	145.8 W	18	26	M 41	10 NM	02	1008.2	14.8	18.0	10	19.5			
SANTA ADELA	KNCS	11	32.8 N	127.8 E	18	02	40	10 NM	02	1007.0	13.3	16.7	8	14.5	02	12	26
UNIVERSE	5LSK	12	37.2 N	161.5 E	06	12	M 47			1003.1	12.0	11.7	5	18	13	5	19.5
PRESIDENT MONROE	WNRD	13	36.2 N	146.0 E	18	06	40	2 NM	65	1002.0	11.7		5	19.5	06	5	19.5
BUNGA MELAWIS	9MUT	14	48.7 N	158.8 W	06	19	M 44	5 NM	60	1005.5	5.5	5.0	5	19.5	20	7	21
PRESIDENT MONROE	WNRD	14	38.6 N	150.9 E	06	05	40	2 NM	07	1008.6	9.4	12.8	3	16.5	03	4	19.5
GLACIER BAY	KACF	14	47.4 N	152.4 W	17	21	45	1 NM	62	1012.0	5.5	6.7	4	13	21	6	19.5
QUEEN OPAL	HBFF	15	49.4 N	158.9 W	23	17	M 40	50 YD	07	0992.0	6.0	6.0	8	23	19	21	23
GOLDEN APO	DUZH	16	49.2 N	171.3 W	00	24	M 54	5 NM	00	0987.5	4.0	5.0	9	29.5	24	10	26
PRESIDENT HOOVER	WTST	16	54.3 N	164.6 W	18	31	M 50			0979.3	- 3.3	3.9	10	21	31	10	14.5
LAURA MAERSK	OYRF	17	48.7 N	164.1 W	00	27	44	5 NM	81	1010.1	7.0	5.5	14	24.5			
STAR THAILAND	DZHR	17	53.9 N	146.7 W	12	25	M 40	2 NM	53	0991.0	3.0	4.0	7	10	26	10	26
QUATSINO SOUND	FLPW?	17	50.3 N	142.7 W	12	25	M 40	5 NM	01	1000.0	4.2	4.0	6	13	26	16	23
MV GREEN MASTER	3ESV3	17	52.6 N	152.7 W	17	28	M 52			1002.0	3.0	3.6	10	19.5	28	10	13
HARBOUR BRIDGE	D5MS	17	52.1 N	145.9 W	18	27	M 48	.25 NM	21	0996.7	3.0	7.0	6	13	27	10	21
CHEVRON CALIFORNIA	WCEN	17	48.6 N	150.8 W	18	27	40	5 NM	07	1014.6	3.9	5.0	4	8	29	6	19.5
DRAGOR MAERSK	OVYZ	19	51.3 N	143.4 W	00	28	42	5 NM	15	1012.8	4.5	6.0	7	19.5			
GREAT OCEAN	3EFI	21	57.3 N	143.4 W	00	13	M 43	5 NM		0992.0	5.0	5.0	6	21	13	7	21
CHEVRON MISSISSIPPI	WXRP	26	55.9 N	140.0 W	00	07	M 42	.5 NM	23	0989.2	3.0	4.4	6	6.5	09	7	19.5
TONSONIA	WJDG	26	34.6 N	120.9 W	06	34	55	5 NM		1010.0	12.2	11.1	3	14.5	32	6	29.5
TONSONIA	WJDG	27	38.4 N	123.9 W	06	33	47	5 NM	00	1012.5	11.1	10.0	3	16.5	33	6	24.5
	PACIFIC	MAY															
PACKING	FLPW?	4	53.7 N	158.8 W	00	29	M 40	10 NM	01	1010.0	7.0	5.0	10	16.5	29	12	19.5
PACKING	FLBX?	6	54.0 N	174.5 W	00	14	M 40	.25 NM	50	0987.0	4.0	4.0	10	19.5	14	14	23
PRESIDENT GRANT	WEZO	6	54.1 N	163.3 W	18	21	M 40	5 NM	03	1001.3	5.0	5.0	3	13	23	8	23
EVER VIGOR	DMCM	12	43.0 N	158.1 W	05	27	M 41	5 NM	01	1016.0	9.5	16.0	10	16.5	27	11	21
MOBIL MERIDIAN	KGSM	13	48.9 N	126.6 W	11	12	55	5 NM	07	1016.2	8.3	7.2	6	19.5	16	6	13
GALVESTON	KBSA	13	49.8 N	127.8 W	12	14	40	2 NM	82	1013.5	8.9	8.3	5	11.5	14	12	19.5
REGINA MAERSK	OXGR	14	47.5 N	156.2 W	05	24	52	1 NM		1019.2	7.0		8	32.5			
	PACIFIC	JUNE															
QUATSINO SOUND	FLBX?	3	52.3 N	130.4 W	00	12	M 40			0998.4	9.0	10.0	8	24.5	11	15	32.5
JAN MAYEN	ELDA8	7	69.6 N	176.7 E	12	14	M 40	.5 NM	24	1008.0	7.0	3.0	10	13	15	10	19.5
GOLDEN ORCHID	3EFE	15	34.9 N	122.5 W	18	22	M 48			1012.0	17.0	23.0	12	16.5	35	14	19.5
ATLANTUS	V6RJ	18	15.7 N	174.7 E	19	24	M 40	5 NM		1000.0	27.0	27.2	XX	16.5	24	XX	19.5
ENE TAURUS	[illegible]	7-	26.9 N	136.- E	12	21	M 46			1009.5	25.5	26.7			23	12	19.5

+ Direction of sea waves same as wind
X Direction or period of waves indeterminate
M Measured wind

NOTE: The observations are selected from those with winds ≥ 40 kn or waves ≥ 20 ft from April through September and 45 kn or 30 ft October through March.

U.S. Voluntary Observing Ship Weather Reports

April, May and June 1985

SHIP NAME	VIA RADIO	VIA MAIL
2ND LT. JOHN P. BOBO	17	27
ACADIA	20	56
ADABELLE LYKES	72	146
ADAM E. CORNELIUS	38	45
ADDIRIYAH	26	
ADONIS	31	69
AL AHMADIAH	77	94
ALASKA STANDARD	17	16
ALBULA	25	97
ALDEN W. CLAUSEN		30
ALEUTIAN DEVELOPER	25	121
ALHERTA LYKES	61	174
ALMUNDENA	3	101
ALPINE ROSE	3	139
ALVA MAERSK	13	26
AM. ALABAMA	7	57
AMELIA TOPIC	46	151
AMERICA SUN	53	89
AMERICAN ALTAIR	67	27
AMERICAN APOLLO	45	138
AMERICAN AQUARIUS	85	22
AMERICAN ARGO	53	104
AMERICAN ASTRONAUT	68	132
AMERICAN CONDOR	57	135
AMERICAN DRACO	6	29
AMERICAN EAGLE	22	20
AMERICAN ENVOY	50	155
AMERICAN HERITAGE	23	
AMERICAN LANCER	7	68
AMERICAN LARK	41	112
AMERICAN LEGION	42	116
AMERICAN LIBERTY	49	67
AMERICAN LYNX	96	131
AMERICAN MARKETER	65	119
AMERICAN MERCHANT	70	113
AMERICAN MONARCH	47	35
AMERICAN NEW JERSEY	40	77
AMERICAN NEW YORK	34	65
AMERICAN PIONEER	56	153
AMERICAN PURITAN	45	154
AMERICAN RESERVIST	26	97
AMERICAN RESOLUTE	25	132
AMERICAN RIGEL	61	205
AMERICAN SKY	6	
AMERICAN TITAN AK-1008	26	55
AMERICAN TRADER	80	173
AMERICAN TROJAN	15	36
AMERICAN VEGA	22	95
AMERICANA	19	
AMOCO BALTIMORE	38	39
AMOCO CAIRO	25	
AMOCO VOYAGER	12	39
AMOCO YORKTOWN	38	45
ANG CHAU		55
ANTELOPE		19
AOM WM. M. CALLAGHAN	18	171
APACHE		22
AQUA CITY	115	99
AQUA GARDEN		70
AQUARIUS	65	113
ARCHON	11	29
ARCO ALASKA	45	36
ARCO ANCHORAGE	19	19
ARCO CALIFORNIA	33	23
ARCO FAIRBANKS	41	34
ARCO HERITAGE	4	33
ARCO INDEPENDENCE	45	49
ARCO JUNEAU	23	21
ARCO PRUDHOE BAY	19	54
ARCO TEXAS	15	19
ARCTIC TOKYO		111
ARGONAUT	14	94
ARILD MAERSK	7	20
ARMAND HAMMER	13	44
ARTHUR M ANDERSON	90	22
ASHLEY LYKES	39	
ASIA HERON	40	92
ASIA INDUSTRY	60	
ATIGUN PAS		4
ATIGUN PASS	37	66
ATLANTIC RAINBOW	11	51
AUSTANGER	19	31
AUSTRAL RAINBOW	42	53
AXEL JOHNSON	16	51
B.T. ALASKA	39	257
B.T. SAN DIEGO	97	291
BALLARD		108
BALTIMORE TRADER	18	52
BAR' ZAN	22	40
BARBER PRIAM	34	30
BARBER TAIF	10	
BARBER TAMPA	13	31
BARBER TEXAS	5	45
BARBER TORA	27	64
BARBER TONSBERG	13	14
BAY BRIDGE	51	
BAYAMON	70	140
BEAUTEOUS	13	14
BELO ORIENTE	7	
BELO RIO	20	73
BERNINA	29	114
BHARATENDU	34	32
BIEHL TRADER		54
BLUE COSMO	66	147
BOGASART DUA	70	166
BOHEME	62	86
BON BATEAU	1	
BORINQUEN	47	179
BRIGHT SUN	95	186
BRINTON LYKES	46	
BROOKS RANGE	20	60
BUNGA MELAWIS	22	72
BURNS HARBOR		140
C.K. APOLLO	1	
CALCITE II	60	20
CALIFORNIA RAINBOW		49
CAMPECHE	1	
CANADIAN HIGHWAY	18	27
CANAL ACE		108
CARLA S. HILLS		24
CASON J. CALLAWAY	81	41
CHARLES E. WILSON		42
CHARLES LYKES	73	111
CHARLES M. BEEGHLEY	25	24
CHARLES PIGOTT		92
CHARLOTTE LYKES	83	200
CHARLOTTE MAERSK	46	118
CHASTINE MAERSK	13	78
CHEMICAL PIONEER	32	122
CHERRY VALLEY	21	49
CHESAPEAKE	33	
CHESNUT HILL	43	91
CHEVRON ANTWERP	9	70
CHEVRON ARIZONA	49	74
CHEVRON CALIFORNIA	146	99
CHEVRON COLORADO	16	47
CHEVRON FELUY	65	62
CHEVRON FRANKFURT	3	
CHEVRON LONDON	14	126
CHEVRON LOUISIANA	34	67
CHEVRON MISSISSIPPI	194	137
CHEVRON NORTH AMERICA	2	173
CHEVRON OREGON	79	103
CHEVRON PACIFIC		98
CHEVRON WASHINGTON	9	25
CHRISTIAN MAERSK	25	48
CITY OF MIDLAND	15	86
CLARA MAERSK	50	112
CLIFFORD MAERSK	13	76
CLOVER TRUST	27	76
COLUMBIA STAR		108
COLUMBUS AMERICA	219	
COLUMBUS LOUISANA	75	
CONDORA	1	
CONTINENTAL HIGHWAY	77	
CONTINENTAL TRADER	21	
CONTRACT TRADER	1	
CORNELIA MAERSK	29	71
CORNUCOPIA	56	135
CRYSTAL STAR	24	66
CYGNUS	50	30
D.L. BOWER		124
DA MOSTO	5	22
DACEBANK	97	
DAGLAND	91	102
DAVID D. IRWIN	8	10
DAVID PACKARD	3	
DAWN	47	110
DELAWARE TRADER	52	102
DOCTOR LYKES	12	
DOLLY TURMAN	15	39
DON JUAN	19	54
DRAGOR MAERSK	55	162
DREW FOSS		22
DUBHE	31	12
DYVI SKAGERAK	30	224
DYVI KATTEGAT		9
EASTERN BRIDE	63	115
EASTERN DIAMOND	10	62
EASTERN FRIENDSHIP	33	86
EASTERN GLORY	19	171
EASTERN GRACE		64
EASTERN ROYAL	73	64
EASTERN VENTURE	17	5
EATON GLORIA	74	
EDGAR M. QUEENY	3	
EDITA	13	
EDWIN W. GOTT		91
ELIZABETH LYKES	10	
EMPIRE STATE	21	
ENDEAVOR	7	11
ERNEST R BREECH	98	92
ESSO PALM BEACH	2	17
ESSO PROVIDENCE	1	
EVER GENIUS	14	34
EVER GENTLE	24	22
EVER GENTRY	10	
EVER GIFTED	27	
EVER GLORY		44
EVER GRAND		1
EVER GREET		3
EVER GUARD		45
EVER LAUREL	37	142
EVER LEVEL	39	69
EVER LINKING		107
EVER LIVING		95
EVER LOADING		6
EVER LYRIC	25	27
EVER ONWARD	42	20
EVER SHINE	12	26
EVER SPRING	27	27
EVER SUMMIT	56	132
EVER SUPERB	75	75
EVER VALIANT	24	61
EVER VALOR	62	94
EVER VALUE	28	35
EVER VIGOR	2	155
EVER VITAL	78	117
EXPORT CHALLENGER	35	150
EXPORT CHAMPION	36	102
EXPORT FREEDOM	29	109
EXPORT PATRIOT	27	106
EXXON BALTIMORE	10	5
EXXON BATON ROUGE	72	87
EXXON BAYTOWN	6	22
EXXON BENICIA	19	39
EXXON BOSTON	95	148
EXXON GETTYSBURG	6	15
EXXON HOUSTON	9	19
EXXON JAMESTOWN	35	32
EXXON LEXINGTON	23	40
EXXON NEW ORLEANS	24	35
EXXON NORTH SLOPE	19	15
EXXON PHILADELPHIA	29	10
EXXON PRINCETON	29	13
EXXON SAN FRANCISCO	3	25
EXXON WASHINGTON	11	22
EXXON YORKTOWN		2
FAIR SEA	4	4
FALCON LEADER	25	74
FALSTRIA	98	74
FEDERAL FRASER	21	46
FERNCROF	68	46
FETISH	33	120
FJORD STAR	16	
FLORIDA RAINBOW		104
FORTALEZA	134	171
FRANCIS SINCERE NO 6	27	23
FRASER	5	
FREDERICK LYKES	1	
FRIENDSHIP	61	
FRISKY	1	
GALVESTON	65	117
GAMA ROBUSTA	7	
GARNET ACE		5
GEDIZ	1	
GEMINI		53
GENERAL M. BELGRANO	32	52
GENEVIEVE LYKES	19	56
GENISTA		60
GEORGE A. SLOAN	7	1
GEORGE A. STINSON		130
GEORGE H. WEYERHAEUSER		182
GEORGE WYTHE	25	64
GERONIMO		64
GLACIER BAY	32	15
GLOBAL FRONTIER	70	167
GLOBAL PIONEER	18	111
GLOBAL SUN	28	19
GLOBE TRADER	19	

SHIP NAME	VIA RADIO	VIA MAIL
GLORIOUS SPICA	24	44
GOLDEN APO	29	48
GOLDEN CLOVER	4	
GOLDEN COAST	1	6
GOLDEN GATE	15	22
GOLDEN GATE BRIDGE	20	20
GOLDEN GRAMPUS	26	30
GOLDEN HAWK	58	75
GOLDEN ORCHID	44	51
GREAT LAND	48	117
GREAT OCEAN	45	55
GREEN FOREST	41	41
GREEN MAYA	42	79
GREEN STAR	56	70
H.J. HAYNES		52
HANJIN CHEJU		27
HANJIN INCHEON	26	36
HANJIN KWANGYANG		43
HANJIN POHANG	35	39
HAREOUR BRIDGE	88	58
HARGANGER	4	12
HASSAN MERCHANT		6
HAUL TRACER		194
HENRY FORD II		28
HERBERT C. JACKSON	56	21
HOEGH CAIRN	15	21
HOEGH CLIPPER	1	
HOEGH DENE	10	31
HOEGH DRAKE	2	53
HOEGH DYKE	27	54
HOEGH HALLARD	10	61
HOEGH MARLIN	38	86
HOEGH MASCOT	7	40
HOEGH MINERVA	29	67
HOEGH MIRANDA	29	111
HOHSING ARROW	25	51
HOHSING BREEZE	62	131
HONSHU GLORIA	1	
HOTAKA MARU	69	30
HOWELL LYKES		8
HOYO MARU	45	56
HUAL TRAVELLER	4	24
HYUNDAI # 14	13	
HYUNDAI # 23	6	
HYUNDAI #3	24	
HYUNDAI CON # 22	19	36
HYUNDAI NO.17	1	59
HYUNDAI NO.6	1	2
INGER	4	17
IRIS ISLAND	34	
IRVIN L. CLYMER	67	35
ITALICA	45	78
J. BURTON AYERS	5	
J. LOUIS	5	59
J.A.W. IGLEHART	36	62
J.L. MAUTHE	74	38
JALAVIJAYA	45	
JALISCO	8	54
JAMES LYKES	5	
JAMES R BARKER		65
JAPAN AMBROSE	83	59
JAPAN APOLLO	47	38
JAPAN RAINBOW	1	
JEAN LYKES	15	28
JOHN A. MC ONE	1	
JOHN G. MUR ON	113	36
JOHN LYKES	1	10
JOSEPH LYKES	15	41
JUNO	16	
KASINA		99
KAUAI	58	172
KENAI	43	179
KENNETH E. HILL		89
KENNETH T. DERR		130
KENWOOD	30	60
KEYSTONE CANYON	13	
KEYSTONER	14	130
KOFUKU MARU	33	103
KOREAN FIR	12	
KOREAN JACEWON	73	102
KOREAN PRIDE	28	
KOREAN WONIS JIN	24	55
KOREAN WONIS ONE	39	19
KOREAN WONIS SEVEN	34	14
KOREAN WONIS SUN	25	18
L.W. FUNKHOUSER	13	
LA MOLINERA	6	53
LA PAMPA		9
LAKE SUWA	65	149
LARS MAERSK	55	141
LASH ATLANTICO	30	106
LASH ITALIA	36	75
LASH PACIFICO	10	55
LAURA MAERSK	58	121
LAUST MAERSK	41	84
LEDA MAERSK	39	87
LEISE MAERSK	31	71
LESLIE LYKES	25	
LEVITTA LYKES	11	8
LEWIS WILSON FOY		159

SHIP NAME	VIA RADIO	VIA MAIL
LIXA MAERSK	42	108
LICA MAERSK	8	42
LILLOOET	21	53
LNG LEO	69	153
LNG TAURUS	22	125
LONG LINES	71	152
LOUIS MAERSK	31	76
LOUISE LYKES	24	87
LUCENT STAR	83	
LUNA MAERSK	27	68
LURLINE	44	207
M P GRACE	3	
M.S. PACIFIC VICTORY		3
M.S. SELVA		101
M.V. BUNGA SRIPAGI	41	84
M.V. CHESAPEAKE TRADER	13	51
M.V. KALIDAS	15	56
M.V. NEPTUNE TOURMALIN		24
M.V. OREGON RAINBOW II		116
M.V. PRESIDENT EISENHO	100	210
M.V. UNITED SPIRIT		1
M/S HAMANASU	10	40
M/S NOSAC SEL		64
M/S SAMMI SPIRIT		9
M/S SEA KING NO.1	41	85
M/S TRIGGER		74
M/T ECLIPSE	20	127
M/V AMERICAN VIRGINIA	18	36
M/V GREEN WAVE	20	51
M/V MARATHA PROVIDENCE	14	54
M/V MEGA TAURUS	25	94
M/V NOSAC EXPRESS	31	37
M/V PAUL BUNYAN	7	94
M/V SPRING BIRDE		277
M/V TIBER	23	46
M/V TONTC VENTURE		27
MAERSK WIND		157
MALACCA	14	
MALLORY LYKES	36	53
MANHATTAN DUKE	30	
MANILA PACIFIC	113	
MANJIN CHEJU		24
MANUKAI	68	159
MANULANI	45	165
MARATHA SHOGUN	46	19
MARCONA CONVEYOR	49	39
MARDI GRAS	5	10
MARESK SEMBAWANG	1	
MARGARET LYKES	88	184
MARIA TOPIC	14	
MARITIME ACE	1	
MARITIME NOBLE	78	88
MARJORIE LYKES	7	20
MARLIN	1	
MARTHA R INGRAM	10	106
MASON LYKES	7	13
MATHILDE MAERSK	2	13
MAUI	71	190
MAURICIO DE OLIVEIRA	31	65
MED TRANSPORTER	25	32
MELBOURNE HIGHWAY		3
MELVILLE	24	39
MEONIA	85	179
MERAK EIGHTY	19	25
MICRONESIAN COMMERCE		86
MICRONESIAN INDEPENDEN	22	17
MIDDLETOWN	3	
MING GALAXY	1	23
MING GLORY	17	
MING MERCY	19	43
MING MOON		45
MING OCEAN	16	17
MING STAR	2	20
MING SUN		15
MING UNIVERSE	15	20
MIXTECO	39	75
MOANA PACIFIC	34	255
MOBIL ARCTIC	61	163
MOBIL MERIDIAN	52	174
MOKU PAHU	139	130
MORMACSTAR	32	22
MORMACSUN	22	86
MOSMAN STAR		52
MOUNTAIN AZALEA	1	
MV GAMONIA	8	36
MV GREEN MASTER		170
MV JAMES ANDERSON, JR.	15	24
MV KENT		42
MV LOUIS J HANGE JR.	12	12
MV LUZON		176
MV ORIENTAL PATRIOT	16	12
MYRON C. TAYLOR	91	64
NACIONAL SANTOS	13	16
NANCY LYKES	8	29
NATIONAL DIGNITY	35	
NATIONAL HONOR	5	32
NATIONAL PRIDE		42
NEPTUNE DIAMOND	26	10
NEW APOLLO		17
NEW INDEPENDENCE	76	242

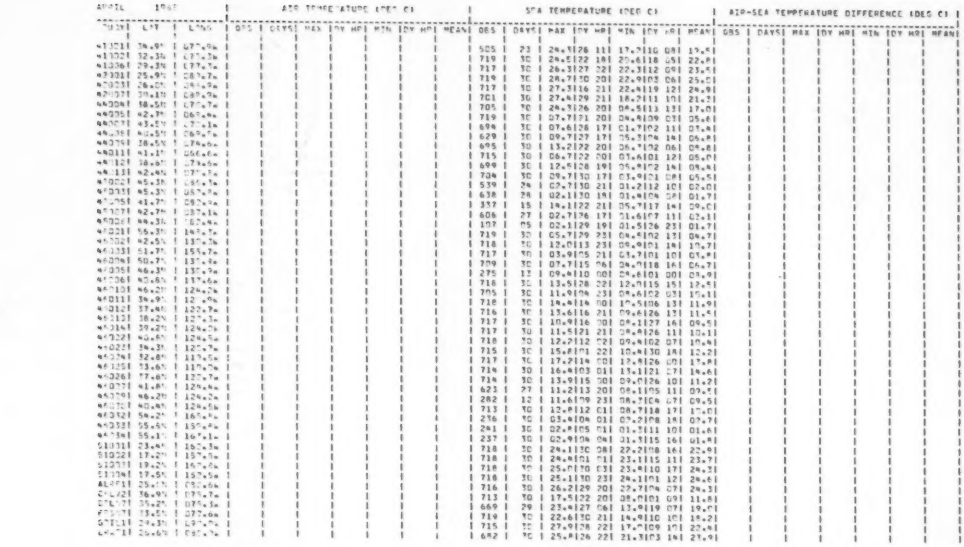
SHIP NAME	VIA RADIO	VIA MAIL
NEWARK	40	68
NICOLA PROSPERITY	17	
NICOLET	37	54
NISSAN MARU	20	37
NOAA DAVID STARR JORDA	29	80
NOAA SHIP ALBATROSS IV	79	234
NOAA SHIP CHAPMAN	72	132
NOAA SHIP DAVIDSON	110	75
NOAA SHIP DELAWARE II	15	
NOAA SHIP DISCOVERER O	166	160
NOAA SHIP FAIRWEATHER	162	188
NOAA SHIP FERREL	4	9
NOAA SHIP MCARTHUR	68	79
NOAA SHIP MILLER FREEM	163	190
NOAA SHIP MT MITCHEL	54	57
NOAA SHIP PIERCE	68	62
NOAA SHIP RAINIER	196	29
NOAA SHIP RESEARCHER	89	140
NOAA SHIP SURVEYOR	180	93
NOAA SHIP WHITING	41	752
NORDHVAL	38	
NORWAY	25	13
NOSAC SEL		67
OAK PEARL		17
OAK SUN		69
OAKLAND	43	24
OBERON	47	90
OCEAN STEELHEAD	36	
OCEANIC	91	167
OCTA	14	55
OGDEN DYNACHEM	5	47
OLEANDER	126	180
ORCO MINER	35	
ORCO TRADER	92	251
ORIENTAL DIPLOMAT		67
ORIENTAL EXECUTIVE	27	124
ORIENTAL EXPLORER	22	126
ORIENTAL GOVERNOR		41
ORIENTAL KNIGHT	38	35
ORIENTAL MINISTER		18
ORIENTAL SOVEREIGN	15	57
ORIENTAL TAIO	45	
OVERSEAS ARCTIC	136	
OVERSEAS BOSTON	44	267
OVERSEAS CHICAGO	8	134
OVERSEAS JUNEAU	22	30
OVERSEAS MARILYN	28	127
OVERSEAS NATALIE	13	
OVERSEAS NEW YORK	45	202
OVERSEAS VIVIAN	12	28
OVERSEAS WASHINGTON	1	125
PACBARON	44	
PACBARONESS	36	25
PACDUCHESS	20	
PACDUKE	24	20
PACEMPEROR	29	
PACGLORY	12	
PACIFIC ANGEL		62
PACIFIC ARROW	184	72
PACIFIC BRIDGE	1	7
PACIFIC EPA	24	
PACIFIC EXPRESS	21	7
PACIFIC LIGHT		32
PACIFIC RAINBOW	38	123
PACIFIC SAGA	33	
PACIFIC SUNSHINE		18
PACIFIC VENTURE	76	147
PACIFIC VICTORY	44	88
PACIFIC WING	61	
PACKING		35
PACLADY	20	
PACMAJESTY	1	
PACMERCHANT	26	11
PACMONARCH	22	
PACNORLE	30	
PANAMA	81	193
PARALLA	27	70
PAUL PIGOTT	2	
PAUL THAYER		49
PENNSYLANIA RAINBOW	78	54
PENNSYLVANIA SUN	15	30
PENNSYLVANIA TRADER	2	2
PFC EUGENE A. OBREGON	33	86
PHILADELPHIA	67	173
PHILADELPHIA SUN	41	61
PHILIP R CLARKE	74	39
PHILLIPS MEXICO	1	
PHOENIX	1	
PILAR	10	96
PINE TRUST		15
PITTSBURGH	60	87
POLAR ALASKA	13	84
POLYNESIA	67	131
PONCE	34	83
PORTLAND	25	54
POTOMAC TRADER	59	149
PRES. F. D. ROOSEVELT	100	128
PRESIDENT CLEVELAND	25	69
PRESIDENT GRANT	44	140
PRESIDENT HOOVER	86	159

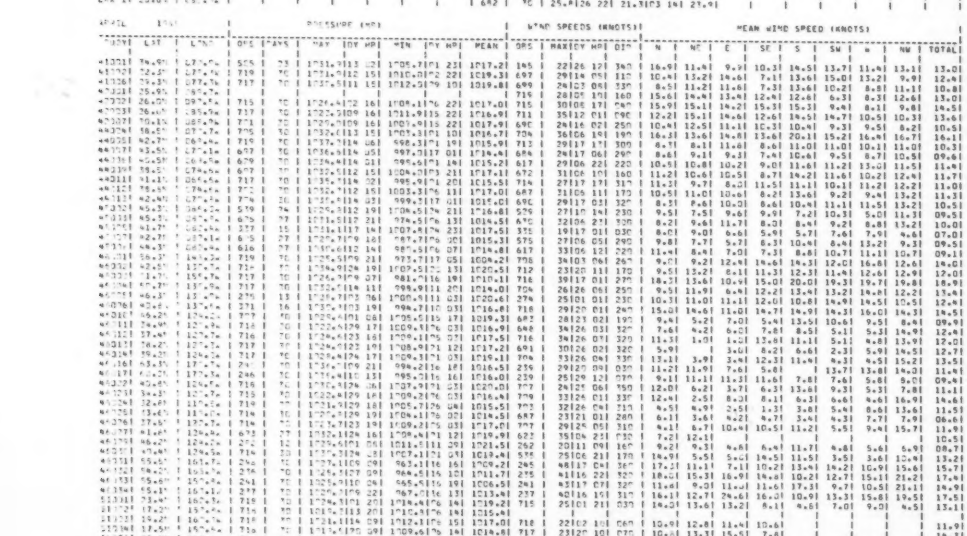
SHIP NAME	VIA RADIO	VIA MAIL
PRESIDENT JACKSON	50	56
PRESIDENT JEFFERSON	49	82
PRESIDENT JOHNSON	31	85
PRESIDENT KENNEDY	19	19
PRESIDENT LINCOLN	74	139
PRESIDENT MADISON	57	161
PRESIDENT MC KINLEY	117	68
PRESIDENT MCKINLEY		94
PRESIDENT MONROE	62	161
PRESIDENT PIERCE	16	53
PRESIDENT ROOSEVELT	1	
PRESIDENT TAYLOR	38	38
PRESIDENT TYLER	32	113
PRESIDENT VAN BUREN	2	
PRESIDENT WASHINGTON	148	169
PRESIDENT WILSON	24	65
PRESQUE ISLE		158
PRIDE OF TEXAS	1	
PRINCE OF TOKYO	52	139
PRINCE WILLIAM SOUND	20	38
PROSPERIDAD	83	46
PROVINCIA DE EL ORO	3	
PUNTA BRAVA	40	27
QUATSINO SOUND		139
QUEEN OPAL	66	47
RADIANT VENTURE	17	
RAINBOW HOPE	17	307
RAPID	46	79
RED ARROW	35	150
REGENT CEDAR	42	10
REGINA MAERSK	43	123
RIO ESOUEL	22	21
RIO GRANDE	36	58
RIO LOS SAUCES	14	23
RIO LUNDE	4	29
ROACHBANK	85	
ROBERT G. CONRAD	20	54
ROBERT E. LEE	23	26
ROSE	1	34
ROSINA TOPIC		46
ROVER	14	111
ROYAL VIKING STAR	10	
RUTH LYKES	60	
S.S. CHILBAR	9	28
S.T. CRAPO	3	
S/T OVERSEAS ALICE	10	17
SACRAMENTO	15	
SAINT LOUIS	33	173
SAM HOUSTON	7	48
SAN JUAN	81	8
SAN PEDRO	9	57
SANKO ANTARES		21
SANKO AZALEA		98
SANKO CYCLAMAN		110
SANKO DEFIANT		79
SANKO DENEB		9
SANKO PEACOCK		2
SANKO PEARL		52
SANKO PINNACLE		17
SANKO SOVEREIGN		62
SANKO STORK		60
SANKO SWALLOW		18
SANKO TURQUOISE		11
SANKO VENUS		20
SANTA ADELA	110	173
SANTA JUANA	78	192
SATURN DIAMOND	10	133
SAUDI DIRIYAH	20	6
SAUDI MAKKAH	37	
SAUDI RIYADH	10	
SAVONITA	28	47
SEA BELLS		40
SEA EXPORTER		36
SEA FAN		158
SEA FORTUNE		83
SEA JADE	35	49
SEA LANTERN	9	92
SEA LIGHT		134
SEALAND ADVENTURER	68	167
SEALAND CONSUMER	69	167
SEALAND DEFENDER	71	119
SEALAND DEVELOPER	15	55
SEALAND ECONOMY	39	178
SEALAND ENDURANCE	45	98
SEALAND EXPLORER	40	100
SEALAND EXPRESS	58	127
SEALAND FREEDOM	46	131
SEALAND INDEPENDENCE	85	160
SEALAND INNOVATOR	23	59
SEALAND LEADER	39	187
SEALAND LIBERATOR	17	83
SEALAND MARINER	45	161
SEALAND PACER	27	153
SEALAND PATRIOT	34	67
SEALAND PIONEER	30	92
SEALAND PRODUCER	46	162
SEALAND VENTURE	79	198
SEALAND VOYAGER	43	104
SEDCO B/P	39	69
SENATOR	29	38
SEVEN OCEAN	36	32
SGT. MATEJ KOCAK	5	7
SHELDON LYKES	105	160
SHIRAHAMA MARU		92
SHIPLEY LYKES	11	55
SILVER SHINKO	7	9
SKAUGRAN	57	102
SKOUBORD	48	122
SOHIO INTREPID	24	116
SOHIO RESOLUTE	66	
SOLON TURMAN	41	106
SONG OF NORWAY	2	
SOUTH LIGHT	18	
SPARROWS POINT	66	121
SPRING BIRD		163
SPRING BREEZE		162
ST. CLAIR		53
STAR CARRIER	5	20
STAR DIEPPE	40	
STAR DOVER	37	20
STAR EAGLE	100	123
STAR INDONESIA	12	
STAR KANDA	92	135
STAR LUZON	2	
STAR MALAYSIA	10	
STAR PHILLIPPINES	3	21
STAR THAILAND	22	71
STARWARD	23	
STATE OF MAINE	32	30
STEADFAST	2	14
STELLA LYKES	17	58
STJERNEORG	3	
STONEWALL JACKSON	18	31
STREAM BOLLARD	55	102
STREAM HAWSER	40	143
SUGAR ISLANDER	10	70
SUN VIKING	37	
SUNBELT DIXIE	132	
TAI LIENG	21	36
TE LAN	47	55
TENCHBANK	175	
TEXACO CONNECTICUT	6	16
TEXACO GEORGIA	1	21
TEXACO MISSISSIPPI		21
TEXACO RHODE ISLAND	4	15
TEXAS CLIPPER	23	
TEXAS SUN	3	4
TEXAS TRADER	60	196
TFL DEMOCRACY	60	168
TFL ENTERPRISE	28	165
TFL EXPRESS	26	83
TFL FRANKLIN	104	
TFL FREEDOM	60	119
TFL INDEPENDENCE	46	119
TFL JEFFERSON	20	55
TFL LIBERTY	60	157
THAMES	1	25
THOMAS G. THOMPSON	189	182
THOMAS WASHINGTON	88	180
THOMPSON LYKES	11	87
THOMPSON PASS	29	59
TILLIE LYKES	26	190
TOHBET MARU	54	10
TOKYO RAINBOW	48	34
TOLTEN		37
TONCI TOPIC	4	
TONSONIA	44	220
TOWER BRIDGE	117	60
TOWNSEND CROMWELL	126	152
TOYOTA #24	144	59
TRADER	27	30
TRANSCOLORADO	14	
TRANSCOLUMBIA	38	84
TRIGGER		72
TRITON	10	25
TROPIC SUN	13	60
TYSON LYKES	53	138
ULTRASEA	16	32
UNICORN		4
UNIVERSE	24	37
USCGC ACUSHNET WMEC 16	14	
USCGC ALERT (WMEC 630)	24	
USCGC BASSWOOD (WLB 38	44	50
USCGC BIBB (WMEC 31)	2	
USCGC BOUTWELL WMEC 71	71	89
USCGC CHEROKEE WMEC 16	29	53
USCGC CHILULA (WMEC 15		238
USCGC CLOVER (WMEC 292	4	62
USCGC CONFIDENCE		13
USCGC COURAGEOUS	13	
USCGC DAUNTLESS WMEC 6	50	28
USCGC DEPENDABLE	8	
USCGC DILIGENCE WMEC 6	95	
USCGC DUANE (WMEC 33)	16	8
USCGC DURABLE (WMEC 62	8	80
USCGC EAGLE (WIX 327)	17	14
USCGC EVERGREEN WMEC 2	1	
USCGC FIREBUSH WLB 393	15	
USCGC GLACIER (WAGB 4)	23	16
USCGC HAMILTON WMEC 71	6	
USCGC INGHAM (WMEC 35)	18	
USCGC IRONWOOD (WLB 29	10	
USCGC LAUREL (WLB 291)	10	20
USCGC MALLOW (WLB 396)	7	
USCGC MIDGETT (WMEC 72		124
USCGC POLAR SEA WAGB 1	112	187
USCGC POLAR STAR WAGB	88	104
USCGC RELIANCE WMEC 61	16	
USCGC RESOLUTE WMEC 62	1	
USCGC SEDGE (WLB 402)	11	
USCGC SHERMAN (WMEC 72	25	
USCGC STOPIS (WMEC 38)	1	
USCGC SUNDEW (WLB 404)	5	9
USCGC SWEETBRIER WLB 4	34	
USCGC TAMAROA (WMEC 16	20	34
USCGC TANEY (WMEC 37)	4	
USCGC VALIANT (WMEC 62	51	
USCGC VENTUROUS WMEC 6		43
USCGC VIGILANT WMEC 61	42	30
USCGC VIGOROUS WMEC 67	37	
USCGC WOODRUSH (WLB 40	1	
USCGC YOCONA (WMEC 168	55	37
USNS APACHE	36	
USNS BARTLETT	41	51
USNS CHAUVENET	85	184
USNS DE STEIGUER	92	133
USNS HARKNESS TAGS 32	60	
USNS KANE TAGS 27		161
USNS LYNCH T-AGOR 7	69	134
USNS MAUMEE	75	176
USNS MISPILLION		33
USNS MISSISSINEWA		79
USNS MOHAWK	28	21
USNS NEOSHO T-AO-143		119
USNS PASSUMPSIC TAO 10		9
USNS PAWCATUCK TAO-108		7
USNS POWHATAN TATF 166	21	
USNS REDSTONE	14	33
USNS PIGEL TAF 58		102
USNS SATURN T-AFSIO		19
USNS SEALIFT ARCTIC	27	73
USNS SEALIFT CARIBBEAN	3	
USNS SEALIFT CHINA SEA	15	121
USNS SEALIFT MED	34	45
USNS SILAS BENT T-AGS	1	
USNS SIRIUS		9
USNS SOUTHERN CROSS	19	
USNS TRUCKEE TAO-147		105
USNS VANGUARD TAG 194	58	96
USNS WACCAMAW(TAO-109)		225
USNS YUKON T-AO 152		67
VALLEY FORGE	12	163
VALOR	19	
VAN CONQUEROR	1	
VAN FORT	45	111
VAN HAWK	42	45
VAN WARRIOR		104
VELMA LYKES	12	59
VENTURE STAR		5
VICTORY ACE		36
VISHVA PRAFULLA	19	9
WALCHAND	1	
WASHINGTON TRADER	48	170
WECOMA	10	120
WESTERN SUN	1	4
WESTWARD VENTURE	6	7
WILLIAM A. POESCH		54
WILLIAM E. MUSSMAN	29	127
WILLIAM HOOPER	37	
WILLIAM J. DELANCEY		148
WOOD STAR	11	41
YAMASHIN MARU	64	23
YASHIMA MARU	22	13
YOUNG SPORTSMAN	11	36
ZEPHUNTER	78	175
ZEUS	15	114
ZOELLA LYKES	19	57
3ELZL2		13
3ETU3		6
5HOZ		38
C6B2		30
D5N2		51
DUPC		12
DZST		16
ELDU44		37
ELUN 0		10
ELUN 1		4
HOAL		27
KPGO		36
KRSE		2
NDGF		64
OYBE		16
WEDB		16
WETEG		94
WGJX		26
YCSG	22	72
YCTB	1	
YCTC	3	
YCTD	71	
YDLR	71	172
YJWH2		42
ZCKD	47	84
ZCKP	15	53
ZENC	62	138
ZEOJ	20	90
ZEUC	8	6

SUMMARY: GRAND TOTAL VIA RADIO 26218 GRAND TOTAL VIA MAIL 54916 TOTAL UNIQUE OBS 66658

U.S. NDBC Climatological Data

April, May and June 1985





APRIL 1985 | TOTAL FREQUENCY OF WIND SPEEDS (%) | TOTAL FREQUENCY OF WIND DIRECTIONS (%)

BUOY#	LAT	LONG	CALM	<4KT	4-10KT	11-21KT	22-33KT	34-47KT	>47KT	N	NE	E	SE	S	SW	W	NW
41001	34.9N	072.9W		2.1	25.5	71.0	1.4			17.1	15.3	10.7	4.8	11.2	8.1	12.2	20.5
41002	32.3N	075.3W		7.2	30.4	56.5	5.7			14.2	8.1	7.4	8.3	13.4	19.0	15.9	13.6
41006	29.3N	077.3W		6.0	40.3	52.9	0.7			11.1	11.7	23.4	2.2	11.8	17.7	12.1	10.2
42001	25.9N	089.7W		4.9	32.7	53.5	8.9			11.0	13.1	18.4	35.0	10.1	3.5	2.0	6.9
42002	26.0N	093.5W		2.7	22.1	62.1	13.1			6.5	14.9	22.8	38.1	9.5	3.4	1.9	3.0
42003	26.0N	085.9W		3.0	32.2	52.0	12.1	0.7		9.7	13.6	34.6	16.8	9.8	2.5	3.4	7.6
42007	30.1N	088.9W		5.7	43.2	50.4	0.7			5.9	9.8	23.3	26.4	13.6	12.0	4.7	4.2
44004	38.5N	070.7W		2.1	22.0	54.1	21.2	0.6		11.8	3.6	12.3	10.4	8.9	10.4	21.6	20.9
44005	42.7N	068.9W		6.0	50.6	41.0	2.4			7.2	6.5	4.7	5.8	11.6	29.1	20.1	19.1
44007	43.5N	070.1W		9.9	48.8	41.2	0.4			11.1	8.5	5.3	5.1	21.1	18.5	12.1	18.3
44008	40.5N	069.5W	1.9	4.7	44.7	46.7	1.9			7.1	7.1	8.9	9.4	12.9	16.9	27.2	10.5
44009	38.5N	074.6W	3.3	3.9	44.9	48.2	6.0			6.4	9.9	13.4	11.1	25.7	12.3	8.1	13.1
44011	41.1N	066.6W		4.9	45.4	45.5	4.2			9.1	8.2	4.8	3.9	10.1	18.7	25.6	20.4
44012	38.8N	074.6W	2.5	5.2	45.4	44.7	4.7			8.6	9.6	13.4	10.5	27.8	10.6	7.7	11.8
44013	42.4N	070.8W	3.0	7.4	47.1	42.9	2.6			8.3	7.6	7.0	14.8	12.0	16.3	17.2	14.7
45002	45.3N	086.3W	3.2	8.1	54.8	33.2	1.9			7.6	3.7	6.1	9.4	11.5	39.1	7.2	15.4
45003	45.3N	082.8W		9.8	51.7	34.9	3.5			6.5	5.6	15.0	13.1	16.9	11.5	11.8	19.6
45005	41.7N	082.4W		14.9	71.3	13.7				4.6	16.5	16.8	19.6	21.1	17.1	4.8	1.6
45007	42.7N	087.1W	3.3	10.4	54.8	31.5	3.3			16.5	7.3	5.8	16.1	31.7	8.6	7.1	7.0
45008	44.3N	082.4W	6.3	8.9	51.8	29.9	3.2			10.2	12.1	11.2	17.2	21.4	11.1	8.5	10.8
46011	34.3N	120.3W		4.2	29.4	51.0	15.3	0.1		5.7	5.1	5.2	8.5	10.6	10.8	37.1	10.9
46022	40.5N	124.5W		3.8	35.4	48.0	8.8			14.6	11.5	8.9	5.4	11.4	12.6	17.3	26.4
46023	51.7N	155.7W		1.1	9.8	55.0	31.6	2.5		6.3	3.4	3.2	5.4	6.4	16.3	38.7	20.4
46034	50.7N	135.9W		4.3	23.7	66.2	5.8			3.5	5.8	6.6	9.9	11.7	23.4	38.2	4.7
46035	46.3N	152.1W		1.1	23.6	60.9	14.4			10.3	10.2	12.3	7.8	1.2	20.8	17.6	11.8
46036	48.8N	137.6W		2.2	27.2	56.5	14.1			11.5	5.8	9.3	12.3	12.0	12.4	19.9	16.9
46108	46.2N	124.2W		12.0	43.5	42.6	1.9			11.0	3.0	5.6	3.7	25.7	9.8	16.8	24.2
46111	34.9N	120.9W		9.0	35.8	46.4	10.6	0.2		12.2	2.0	0.8	1.4	6.4	4.8	4.1	69.1
46121	37.4N	122.7W		8.1	37.0	42.9	11.9	0.1		14.5	0.1	0.1	2.1	7.9	4.2	10.1	61.0
46131	38.2N	123.3W		8.2	35.5	43.1	13.2			2.1		0.1	5.7	5.4	2.0	6.8	78.0
46146	39.2N	124.8W		6.4	29.8	49.9	13.9			22.9	0.5	0.8	3.0	11.0	2.3	2.2	56.5
46161	63.3N	170.3W		7.9	36.4	50.6	5.0			24.2	52.1	9.9	1.6		0.3	2.8	8.9
46177	60.3N	172.3W		12.1	51.5	33.1	3.3			41.1	16.9	10.9	3.1	7.4	6.3	1.3	13.0
46221	40.8N	124.5W		7.6	33.5	57.7	1.1			64.9	3.0	0.9	2.2	12.0	5.0	4.6	7.4
46223	34.3N	127.7W		4.4	29.1	48.5	18.1			10.3	11.2	0.1	5.7	4.7	4.4	2.9	74.4
46224	32.8N	119.5W		10.1	35.1	49.6	5.1			3.3	0.5	1.3	0.6	1.9	6.2	18.0	68.1
46225	33.6N	119.0W		23.7	59.7	15.4	1.2			5.1	2.0	7.0	5.7	5.1	9.6	47.1	18.5
46226	37.8N	122.7W		6.5	42.0	43.6	7.9			1.3	0.8	1.0	1.3	6.9	7.2	38.8	42.8
46237	41.8N	124.4W	10.1	15.2	38.0	40.4	6.1	0.2		31.6	68.4						
46239	46.2N	130.2W		20.2	38.9	40.8				12.7	9.9	2.5	5.9	37.4	5.3	13.5	17.8
46301	40.4N	124.5W	3.6	7.1	24.5	65.6	2.8			58.0	4.3	0.4	11.6	14.1	2.2	1.1	8.2
46311	55.5N	161.7W		5.3	13.5	65.7	13.1	2.0	0.4	59.2	7.3	1.8	1.8	7.4	8.8	1.4	12.1
46312	54.2N	165.8W			22.6	48.1	27.2	2.1		23.0	2.3	6.3	11.1	9.9	5.1	9.1	33.2
46313	55.8N	159.8W		1.7	40.7	37.0	20.3	3.3		17.5	23.5	3.8	1.2	3.8	3.8	4.4	41.2
46341	55.1N	163.1W		0.8	14.3	54.9	28.3	1.7		27.0	7.4	2.6	15.6	3.1	2.0	7.6	34.7
51001	23.4N	162.3W		0.0	18.2	78.3	2.7			0.0	33.8	52.9	4.2	0.4	<.05	0.1	0.6
51003	19.2N	160.8W		0.1	32.5	66.9	0.6			0.5	35.9	56.9	6.6				
51004	17.5N	152.5W		0.4	19.7	79.6	0.3			3.3	46.7	49.1	0.9				
ALRF1	25.0N	080.6W	2.9	7.3	36.0	53.8	12.4			4.2	20.9	41.1	9.6	7.1	5.0	5.9	6.0
ALSN6	40.5N	073.8W	1.6	6.5	23.2	55.5	12.5	2.3		10.6	5.7	13.3	11.7	4.9	16.3	15.1	22.5
BURL1	28.9N	089.4W	1.6	8.9	40.7	48.8	1.6			12.1	22.7	25.3	9.0	9.3	12.9	2.6	6.2
CAR03	43.4N	124.7W	6.1	19.4	46.3	31.4	2.7			32.3	11.8	2.5	5.2	18.4	17.3	7.5	4.9
CHLV2	36.9N	075.7W	1.1	5.7	26.0	51.4	16.7	0.1		7.6	10.3	9.8	16.1	17.0	13.9	12.4	12.8
CLKN7	34.7N	076.5W	2.3	7.6	50.1	37.9	2.4			6.8	7.4	5.2	11.4	33.4	15.0	6.1	9.1
CSSF1	29.7N	085.4W	6.5	26.6	61.8	11.5	0.2			8.3	13.9	18.2	14.3	15.9	10.0	11.9	7.4
DBLN6	42.5N	079.4W	3.1	13.4	47.2	30.7	7.5	1.0	0.1	4.8	11.8	5.0	9.8	13.1	39.4	10.9	5.0
DESW1	47.7N	124.5W	3.1	13.1	39.8	38.8	5.2			4.6	5.7	5.5	17.7	21.0	8.4	16.1	20.9
DISW3	47.1N	090.7W	2.0	7.1	43.6	40.3	9.1			8.8	28.9	10.0	5.3	6.6	16.7	8.4	15.1
DSLN7	35.2N	075.3W	1.2	7.9	51.3	32.3	7.0	3.4		11.1	5.6	4.9	5.4	32.0	16.4	9.5	9.5
FRIS1	32.7N	079.9W	2.4	17.0	60.3	22.5	0.1			4.5	9.3	17.3	7.4	10.1	25.1	15.5	10.8
FFIA2	57.3N	133.6W	4.8	7.7	34.8	45.2	12.2			10.5	9.7	7.4	35.9	23.7	7.9	2.2	2.8
FPSN7	33.5N	077.6W	3.8	6.4	34.3	44.5	14.8			7.9	12.6	8.6	3.2	9.7	30.7	19.3	8.1
GDIL1	29.3N	090.0W	1.7	8.1	43.4	47.1	1.6			5.4	14.9	21.0	23.9	11.9	12.6	5.2	5.2
GLLN6	42.9N	070.2W	1.9	7.2	41.4	49.4	9.7	0.3		4.8	12.8	6.9	10.0	16.4	20.5	20.5	8.3
IOSN3	43.0N	070.6W	1.8	4.6	33.5	51.0	8.5	0.4		4.8	8.0	6.2	12.4	16.1	13.5	16.6	18.4
LKWF1	26.6N	080.0W	2.1	9.3	51.2	38.8	0.7			3.5	12.0	36.4	14.3	12.6	6.2	6.3	8.7
MDRM1	43.6N	069.1W	1.4	6.8	28.2	49.8	14.5	0.7		9.4	6.2	7.0	6.3	12.3	24.9	19.3	14.7
MISM1	43.8N	068.9W		8.2	27.1	48.2	14.4	2.1		8.3	5.4	7.9	5.4	12.6	27.4	17.0	10.1
NWPO3	44.6N	124.1W	12.3	21.6	40.1	33.6	3.9	0.7		22.0	6.2	11.4	2.2	15.8	19.7	12.1	10.6
PTAC1	39.0N	123.7W	5.3	14.3	44.4	37.2	4.2			58.6	16.6	0.8	2.0	15.4	3.6	1.2	5.8
PTAT2	27.8N	097.5W	0.7	4.2	30.9	57.0	7.9			5.5	14.9	34.9	31.8	8.2	0.8	1.6	2.2
PTGC1	34.6N	120.7W	5.7	14.9	24.9	40.2	16.9	1.1		52.8	0.9	0.1	5.0	19.5	1.6	0.8	19.2
RCAN4	47.9N	089.3W	1.9	4.7	22.6	51.9	20.8			4.2	35.6	15.6	0.6	8.5	14.6	7.5	2.4
SRIG1	41.7N	082.8W	7.6	8.7	46.0	31.2	12.0	2.1		2.2	7.0	12.9	14.2	12.8	22.7	15.8	12.4
SONW3	43.8N	087.7W	3.3	10.1	37.7	46.0	6.2			12.2	14.6	3.7	6.9	26.2	9.8	13.0	11.4
STSW1	48.3N	122.9W	6.1	23.4	54.3	18.9	3.4			3.0	2.1	1.8	11.1	17.1	12.5	38.2	14.1
SJLF1	30.4N	081.4W	2.5	9.4	68.2	21.5	0.8			4.4	19.2	16.4	14.8	11.6	10.0	14.1	7.1
SRST2	29.7N	094.1W	2.3	5.5	33.0	57.2	4.0			4.2	11.4	29.8	27.8	10.0	3.0	3.0	5.7
STDM4	47.2N	087.2W	2.4	6.4	23.3	47.6	22.7	2.1		15.5	8.2	8.0	16.6	25.9	6.8	7.6	11.4
TTIW1	48.4N	124.7W	2.9	12.1	39.7	36.0	12.1	0.1		0.9	7.9	12.3	5.5	24.2	19.6	21.3	8.3
WPOW1	47.7N	122.4W	5.6	15.7	50.5	30.5	3.3			16.8	21.3	1.7	6.9	43.4	8.6	0.4	0.9

APRIL 1985 | WAVE HEIGHTS (METERS) | FREQUENCY OF WAVE HEIGHTS (%)

BUOY#	LAT	LONG	OBS	MAX	DY	HR	MEAN	<1M	1-1.5M	2-2.5M	3-3.5M	4-5.5M	6-7.5M	8-9.5M	>9.5M
41001	34.9N	072.9W	503	7.0	15	02	2.1	2.9	38.7	34.3	12.9	9.9	0.9		
41002	32.3N	075.3W	696	6.0	04	12	1.7	0.5	59.7	25.7	10.2	3.5	0.1		
41006	29.3N	077.3W	715	4.0	13	19	1.4	4.8	73.0	17.2	4.6	0.2			
42001	25.9N	089.7W	696	3.0	01	00	1.2	33.1	41.6	24.1	1.0				
42002	26.0N	093.5W	700	3.5	09	00	1.3	15.5	54.7	28.1	1.5				
42003	26.0N	085.9W	716	5.0	12	12	1.1	41.5	43.4	9.6	3.5	1.8			
42007	30.1N	088.9W	583	2.5	13	17	0.7	66.2	31.3	2.5					
44004	38.5N	070.7W	689	6.5	06	23	1.7	15.8	46.2	26.1	6.5	4.7	0.4		
44005	42.7N	068.9W	716	5.0	17	13	1.4	16.9	55.8	19.6	5.8	1.8			
44007	43.5N	070.1W	619	3.0	01	21	0.8	61.7	31.8	5.4	0.9				
44008	40.5N	069.5W	619	5.0	06	21	1.3	25.3	46.5	21.4	4.5	2.1			
44011	41.1N	066.6W	711	5.5	01	08	1.8	10.2	42.2	31.6	6.5	7.5			
45002	45.3N	082.8W	481	5.0	07	00	1.0	52.3	38.5	13.3	1.8	1.8			
45005	41.7N	082.4W	109	1.5	17	01	0.6	72.4	27.5						
45007	42.7N	087.1W	423	3.0	06	09	0.8	55.7	34.5	8.0	1.6				
45008	44.3N	082.4W	395	4.0	06	14	1.0	48.8	35.4	11.1	4.0	0.5			
44010	44.3N	078.0W	719	9.0	01	08	2.0	0.8	17.6	30.1	23.9	20.3	6.5	0.4	
46021	42.5N	130.3W	718	6.0	19	05	2.4		17.4	53.2	23.8	5.4	0.1		
46031	51.7N	155.7W	715	12.0	17	00	3.5		5.5	26.4	35.8	25.3	7.0	1.5	1.3
46034	50.7N	135.9W	717	7.5	16	03	3.0		2.6	40.5	38.4	13.9	4.3		
46036	48.8N	137.6W	717	5.0	19	04	2.4		15.0	55.3	24.2	4.3			
46101	54.2N	124.5W	672	6.5	19	17	2.0	1.4	34.4	44.4	13.5	3.7			
46111	34.9N	120.9W	718	5.5	25	22	1.8		55.7	29.6	7.3	7.2			
46121	37.4N	122.7W	713	5.0	25	03	1.9	0.1	49.6	37.0	8.6	4.4			
46131	38.2N	123.3W	699	4.5	24	13	2.1		38.4	42.4	13.8	5.1			
46146	39.2N	124.8W	713	4.0	19	22	2.0	0.4	39.1	41.5	13.2	5.7			
46221	40.8N	124.5W	713	4.5	19	12	2.1	0.5	28.6	53.0	16.1	1.6			
46223	34.3N	120.7W	709	6.5	26	07	2.2		37.2	44.5	9.3	9.1	0.7		
46224	32.8N	119.5W	709	6.0	26	03	2.0		46.9	37.5	8.0	6.7	0.7		
46225	33.6N	119.0W	710	3.5	26	03	1.1	15.9	72.8	10.4	0.8				
46226	37.8N	122.7W	709	3.5	25	04	1.8		63.8	28.6	5.6				
46027	41.8N	124.4W	622	4.5	19	20	1.9	1.4	39.3	47.7	9.6	1.9			
46029	46.2N	124.2W	242	3.5	11	13	1.8	2.9	42.9	47.1	7.4				
51001	23.4N	162.3W	716	4.0	01	20	2.4		9.2	68.0	22.2	0.6			
51002	17.2N	157.8W	717	3.5	03	01	2.2		18.0	73.2	10.7				
51003	19.2N	160.8W	716	4.0	02	14	2.1		18.6	74.4	6.5	0.4			
51004	17.5N	152.5W	717	3.5	03	02	2.5		2.6	63.4	33.8				
CAR03	43.4N	124.7W	123	0.0	00	00	0.0								30.0
CHLV2	36.9N	075.7W	738	3.0	15	11	0.9	45.4	50.0	4.2	0.2				

MAY 1985

AIR TEMPERATURE (DEG C)

BUOY#	LAT	LONG	OBS	DAYS	MAX	DY HR	MIN	DY HR	MEAN
41001	34.9N	072.4W							
41002	32.3N	075.4W							
41036	29.2N	077.5W							
42001	25.9N	089.7W							
42002	26.0N	093.5W							
42003	26.0N	085.9W							
42019	27.9N	095.4W							
42020	26.9N	096.7W							
44004	38.5N	070.7W							
44005	43.2N	069.1W							
44007	43.5N	070.1W							
44008	40.5N	069.5W							
44009	38.5N	074.6W							
44011	41.1N	066.6W							
44012	38.8N	074.6W							
44013	42.4N	070.8W							
45002	45.3N	086.4W							
45003	45.3N	082.8W							
45005	41.7N	082.4W							
45007	42.7N	087.1W							
45008	44.3N	082.4W							
46011	34.9N	120.9W							
46012	37.4N	122.7W							
46013	38.2N	123.3W							
46014	39.2N	124.0W							
46015	42.7N	124.8W							
46022	40.8N	124.5W							
46023	34.5N	120.7W							
46025	33.7N	119.1W							
46026	37.8N	122.7W							
46027	41.8N	124.4W							
46028	35.8N	121.9W							
46029	46.1N	124.5W							
46030	40.4N	124.5W							
46031	55.1N	163.1W							
46035	57.0N	177.6W							
46036	48.3N	124.0W							
46041	47.3N	124.7W							
46042	36.8N	122.4W							
46047	32.4N	119.5W							
46053	34.2N	119.8W							
46054	34.3N	120.5W							
46059	38.1N	130.0W							
46060	60.6N	146.8W							
46061	59.9N	148.0W							
46066	52.7N	155.0W							
46070	24.8N	164.2W							
46071	51.1N	179.1W							
46072	20.7N	158.0W							
46073	20.7N	156.8W							
46075	53.9N	160.8W							
46076	19.2N	155.8W							
46077	34.9N	120.9W							
46078	26.1N	126.7W							
46080	57.9N	152.5W							
46081	48.2N	126.0W							
46082	17.5N	157.8W							
46083	51.8N	176.1W							
46084	49.2N	128.2W							
46085	36.1N	127.4W							
46086	32.5N	118.0W							
46087	48.5N	124.9W							
46088	48.3N	123.2W							
46089	45.9N	125.8W							
46090	44.6N	124.3W							
46091	34.5N	120.8W							
46092	34.9N	120.8W							
46093	34.3N	120.7W							
46094	32.6N	119.5W							
46095	42.6N	125.5W							
46096	36.7N	123.0W							
46097	44.3N	124.1W							
46098	48.2N	127.9W							
46099	48.3N	129.0W							
46100	46.9N	130.4W							
46131	34.4N	119.7W							
46132	48.3N	122.6W							
46145	51.4N	129.9W							
46146	49.3N	123.7W							
46147	73.2N	140.8W							
46148	49.9N	123.7W							
46183	66.3N	140.0W							
46184	50.9N	140.8W							
46185	50.9N	140.8W							
46186	40.8N	126.7W							
46187	61.4N	146.7W							
46188	57.0N	146.3W							
46189	45.4N	125.3W							
46190	36.2N	122.0W							
46191	37.0N	122.5W							
46192	36.8N	122.0W							
46193	34.3N	119.8W							
46194	34.3N	120.5W							
46195	46.2N	124.1W							
46196	36.7N	121.9W							
46197	50.9N	144.8W							
46198	38.0N	123.5W							
46199	33.6N	119.0W							
46200	46.1N	130.2W							
46201	63.4N	148.1W							
46202	32.5N	117.2W							
46203	31.9N	116.6W							
46204	51.4N	131.0W							
46205	46.1N	131.1W							
46206	49.8N	137.3W							
46207	50.2N	127.9W							
46208	44.2N	125.8W							
46209	45.9N	130.2W							
46210	46.7N	124.2W							
46211	46.9N	124.2W							
46212	40.8N	124.6W							
46213	38.0N	123.5W							
46214	37.9N	122.5W							
46215	36.2N	121.9W							
46216	35.7N	121.4W							
46217	45.8N	123.9W							
46218	34.4N	119.8W							
46219	23.2N	158.1W							
46220	38.9N	123.7W							
46221	34.4N	118.0W							
46222	33.6N	117.5W							
46223	32.8N	117.2W							
46224	32.8N	117.2W							
46225	32.9N	117.4W							
46226	32.9N	117.4W							
46227	32.8N	117.3W							
46228	32.9N	117.4W							
46229	43.8N	124.5W							
46230	32.8N	117.3W							
46231	58.3N	136.8W							
46232	33.6N	118.0W							
46233	33.6N	118.0W							
46234	44.6N	124.9W							
46235	60.2N	146.8W							
46236	32.9N	117.4W							
46237	37.8N	122.6W							
46238	33.9N	118.6W							
46239	37.8N	122.7W							
46240	44.3N	124.9W							
46241	57.8N	152.5W							
46242	50.9N	140.8W							
46243	51.4N	131.0W							
46244	44.0N	069.1W							
46245	43.6N	068.9W							
46246	50.0N	145.0W							
46247	20.6N	157.0W							
46248	48.2N	088.4W							
46249	44.3N	063.6W							
46250	42.5N	070.8W							
46251	48.7N	126.5W							
46252	47.1N	090.7W							
46253	35.2N	120.8W							
46254	32.7N	079.9W							
46255	57.3N	133.6W							
46256	57.3N	137.5W							
46257	29.3N	090.5W							
46258	27.9N	093.6W							
46259	43.0N	070.6W							
46260	44.0N	066.1W							
46261	43.8N	068.9W							
46262	37.8N	122.7W							
46263	41.8N	124.4W							
46264	35.8N	121.9W							
46265	38.2N	123.3W							
46266	39.2N	124.0W							
46267	42.7N	124.8W							
46268	40.8N	124.5W							
46269	34.5N	120.7W							
46270	25.9N	089.7W							
46271	41.8N	124.4W							
46272	35.8N	121.9W							
46273	40.4N	124.5W							
46274	54.2N	165.8W							
46275	55.1N	163.1W							
51001	23.4N	162.2W							
51002	17.2N	157.8W							
51003	19.2N	160.8W							
51004	17.5N	157.5W							
ALRF1	25.0N	080.6W							
CHLV2	36.9N	075.7W							
FPSN7	33.5N	077.6W							
GDLL1	29.3N	090.0W							
LRNF1	26.6N	080.0W							
SVLS1	32.0N	080.7W							

SEA TEMPERATURE (DEG C)

BUOY#	LAT	LONG	OBS	DAYS	MAX	DY HR	MIN	DY HR	MEAN
41001	34.9N	072.4W	739	31	24.5103	041	19.2106	151	22.01
41002	32.3N	075.4W	742	31	25.9131	211	21.5105	101	23.61
41036	29.2N	077.5W	743	31	28.1130	211	23.8121	051	25.21
42001	25.9N	089.7W	341	15	29.8108	211	25.1104	091	27.31
42002	26.0N	093.5W	687	30	30.3124	001	24.3104	121	26.91
42003	26.0N	085.9W	744	31	29.9174	221	25.2108	121	27.01
42019	27.9N	095.4W	610	27	27.3129	211	23.4105	151	25.31
44004	38.5N	070.7W	737	31	25.9131	211	14.2103	151	20.31
44005	43.2N	069.1W	743	31	10.7123	211	06.0103	201	07.51
44007	43.5N	070.1W	718	31	10.8122	211	04.0108	111	06.71
44008	40.5N	069.5W	722	31	13.6126	211	07.1104	121	09.71
44009	38.5N	074.6W	731	31	18.5114	211	09.8101	071	14.11
44011	41.1N	066.6W	742	31	10.6124	201	04.7101	061	06.91
44012	38.8N	074.6W	729	31	17.9121	221	09.8102	171	13.61
44013	42.4N	070.8W	731	31	13.6122	201	07.0103	221	09.91
45002	45.3N	086.4W	730	31	03.9129	161	01.9103	121	02.81
45003	45.3N	082.8W	728	31	03.0129	201	01.8102	111	02.41
45005	41.7N	082.4W	729	31	18.3127	191	09.2102	031	13.41
45007	42.7N	087.1W	731	31	04.0131	181	02.4103	121	03.21
45008	44.3N	082.4W	732	31	07.6124	001	01.6101	011	02.81
46011	34.3N	120.9W	744	31	17.5124	071	09.5101	141	06.71
46012	37.4N	122.7W	741	31	12.8124	011	11.0103	151	11.71
46013	38.2N	123.3W	742	31	05.2126	021	03.9101	001	04.31
46014	39.2N	124.0W	740	31	05.2126	011	04.1105	121	07.51
46015	42.7N	124.8W	211	27	10.7118	001	09.1112	061	10.01
46022	40.8N	124.5W	742	31	14.4119	011	12.7102	151	13.31
46023	34.5N	120.7W	727	31	15.4125	001	09.8115	131	12.21
46025	33.7N	119.1W	743	31	13.3117	201	10.4125	101	11.71
46026	37.8N	122.7W	743	31	14.8123	231	10.7104	141	12.21
46027	41.8N	124.4W	730	31	11.5118	011	08.2109	141	09.41
46028	35.8N	121.9W	623	31	13.3131	211	09.9116	111	10.71
46029	46.1N	124.5W	743	31	13.5130	211	09.2115	041	10.81
46030	40.4N	124.5W	738	31	14.2107	211	10.5101	101	12.21
46035	57.0N	177.6W	739	31	15.6116	231	12.5102	141	13.41
46036	48.3N	124.0W	744	31	17.4129	211	13.8110	101	15.01
46041	47.3N	124.7W	742	31	13.0124	001	09.4105	051	11.21
46042	36.8N	122.4W	742	31	12.4123	221	07.4115	111	09.31
46047	32.4N	119.5W	578	25	14.2126	231	10.7104	111	12.41
46053	34.2N	119.8W	743	31	12.9123	181	08.8101	071	10.01
46054	34.3N	120.5W	241	31	04.6130	031	02.4101	001	03.31
46059	38.1N	130.0W	247	31	05.2131	011	01.7101	011	02.81
46060	60.6N	146.8W	744	31	25.0125	021	23.5122	111	24.01
46061	59.9N	148.0W	743	31	26.1120	011	23.9101	171	24.41
46066	52.7N	155.0W	744	31	25.3105	011	24.5123	041	24.81
46070	24.8N	164.2W	743	31	26.5120	041	24.5127	021	24.81
46071	51.1N	179.1W	741	31	29.5121	221	24.4102	101	27.11
46072	20.7N	158.0W	731	31	21.7128	191	12.8104	011	17.41
46073	20.7N	156.8W	741	31	25.0116	201	19.7104	061	22.71
46075	53.9N	160.8W	716	31	29.4129	221	22.4104	071	26.61
46076	19.2N	155.8W	649	28	28.2130	231	24.2125	171	25.91
46077	34.9N	120.9W	362	16	25.6131	211	20.0123	111	23.81
46078	26.1N	126.7W							
46080	57.9N	152.5W							
46081	48.2N	126.0W							
46082	17.5N	157.8W							
46083	51.8N	176.1W							
46084	49.2N	128.2W							
46085	36.1N	127.4W							
46086	32.5N	118.0W							
46087	48.5N	124.9W							
46088	48.3N	123.2W							
46089	45.9N	125.8W							
46090	44.6N	124.3W							
46091	34.5N	120.8W							
46092	34.9N	120.8W							
46093	34.3N	120.7W							
46094	32.6N	119.5W							
46095	42.6N	125.5W							
46096	36.7N	123.0W							
46097	44.3N	124.1W							
46098	48.2N	127.9W							
46099	48.3N	129.0W							
46100	46.9N	130.4W							
46131	34.4N	119.7W							
46132	48.3N	122.6W							
46145	51.4N	129.9W							
46146	49.3N	123.7W							
46147	73.2N	140.8W							
46148	49.9N	123.7W							
46183	66.3N	140.0W							
46184	50.9N	140.8W							
46185	50.9N	140.8W							
46186	40.8N	126.7W							
46187	61.4N	146.7W							
46188	57.0N	146.3W							
46189	45.4N	125.3W							
46190	36.2N	122.0W							
46191	37.0N	122.5W							
46192	36.8N	122.0W							
46193	34.3N	119.8W							
46194	34.3N	120.5W							
46195	46.2N	124.1W							
46196	36.7N	121.9W							
46197	50.9N	144.8W							
46198	38.0N	123.5W							
46199	33.6N	119.0W							
46200	46.1N	130.2W							
46201	63.4N	148.1W							
46202	32.5N	117.2W							
46203	31.9N	116.6W							
46204	51.4N	131.0W							
46205	46.1N	131.1W							
46206	49.8N	137.3W							
46207	50.2N	127.9W							
46208	44.2N	125.8W							
46209	45.9N	130.2W							
46210	46.7N	124.2W							
46211	46.9N	124.2W							
46212	40.8N	124.6W							
46213	38.0N	123.5W							
46214	37.9N	122.5W							
46215	36.2N	121.9W							
46216	35.7N	121.4W							
46217	45.8N	123.9W							
46218	34.4N	119.8W							
46219	23.2N	158.1W							
46220	38.9N	123.7W							
46221	34.4N	118.0W							
46222	33.6N	117.5W							
46223	32.8N	117.2W							
46224	32.8N	117.2W							
46225	32.9N	117.4W							
46226	32.9N	117.4W							
46227	32.8N	117.3W							
46228	32.9N	117.4W							
46229	43.8N	124.5W							
46230	32.8N	117.3W							
46231	58.3N	136.8W							
46232	33.6N	118.0W							
46233	33.6N	118.0W							
46234	44.6N	124.9W							
46235	60.2N	146.8W							
46236	32.9N	117.4W							
46237	37.8N	122.6W							
46238	33.9N	118.6W							
46239	37.8N	122.7W							
46240	44.3N	124.9W							
46241	57.8N	152.5W							
46242	50.9N	140.8W							
46243	51.4N	131.0W							
46244	44.0N	069.1W							
46245	43.6N	068.9W							
46246	50.0N	145.0W							
46247	20.6N	157.0W							
46248	48.2N	088.4W							
46249	44.3N	063.6W							
46250	42.5N	070.8W							
46251	48.7N	126.5W							
46252	47.1N	090.7W							
46253	35.2N	120.8W							
46254	32.7N	079.9W							
46255	57.3N	133.6W							
46256	57.3N	137.5W							
46257	29.3N	090.5W							
46258	27.9N	093.6W							
46259	43.0N	070.6W							
46260	44.0N	066.1W							
46261	43.8N	068.9W							
46262	37.8N	122.7W							
46263	41.8N	124.4W							
46264	35.8N	121.9W							
46265	38.2N	123.3W							
46266	39.2N	124.0W							
46267	42.7N	124.8W							
46268	40.8N	124.5W							
46269	34.5N	120.7W							
46270	25.9N	089.7W							
46271	41.8N	124.4W							
46272	35.8N	121.9W							
46273	40.4N	124.5W							
46274	54.2N	165.8W							
46275	55.1N	163.1W							
51001	23.4N	162.2W							
51002	17.2N	157.8W							
51003	19.2N	160.8W							
51004	17.5N	157.5W							
ALRF1	25.0N	080.6W							
CHLV2	36.9N	075.7W							
FPSN7	33.5N	077.6W							
GDLL1	29.3N	090.0W							
LRNF1	26.6N	080.0W							
SVLS1	32.0N	080.7W							

AIR-SEA TEMPERATURE DIFFERENCE (DEG C)

BUOY#	LAT	LONG	OBS	DAYS	MAX	DY HR	MIN	DY HR	MEAN
41001	34.9N	072.4W							
41002	32.3N	075.4W							
41036	29.2N	077.5W							
42001	25.9N	089.7W							
42002	26.0N	093.5W							
42003	26.0N	085.9W							
42019	27.9N	095.4W							
42020	26.9N	096.7W							
44004	38.5N	070.7W							
44005	43.2N	069.1W							
44007	43.5N	070.1W							
44008	40.5N	069.5W							
44009	38.5N	074.6W							
44011	41.1N	066.6W							
44012	38.8N	074.6W							
44013	42.4N	070.8W							
45002	45.3N	086.4W							
45003	45.3N	082.8W							
45005	41.7N	082.4W							
45007	42.7N	087.1W							
45008	44.3N	082.4W							
46011	34.9N	120.9W							
46012	37.4N	122.7W							
46013	38.2N	123.3W							
46014	39.2N	124.0W							
46015	42.7N	124.8W							
46022	40.8N	124.5W							
46023	34.5N	120.7W							
46025	33.7N	119.1W							
46026	37.8N	122.7W							
46027	41.8N	124.4W							
46028	35.8N	121.9W							
46029	46.1N	124.5W							
46030	40.4N	124.5W							
46031	55.1N	163.1W							
46035	57.0N	177.6W							
46036	48.3N	124.0W							
46041	47.3N	124.7W							
46042	36.8N	122.4W							
46047	32.4N	119.5W							
46053	34.2N	119.8W							
46054	34.3N	120.5W							
46059	38.1N	130.0W							
46060	60.6N	146.8W							
46061	59.9N	148.0W							
46066	52.7N	155.0W							
46070	24.8N	164.2W							
46071	51.1N	179.1W							
46072	20.7N	158.0W							
46073	20.7N	156.8W							
46075	53.9N	160.8W							
46076	19.2N	155.8W							
46077	34.9N	120.9W							
46078	26.1N	126.7W							
46080	57.9N	152.5W							
46081	48.2N	126.0W							
46082	17.5N	157.8W							
46083	51.8N	176.1W							
46084	49.2N	128.2W							
46085	36.1N	127.4W							
46086	32.5N	118.0W							
46087	48.5N	124.9W							
46088	48.3N	123.2W							
46089	45.9N	125.8W							
46090	44.6N	124.3W							
46091	34.5N	120.8W							
46092	34.9N	120.8W							
46093	34.3N	120.7W							
46094	32.6N	119.5W							
46095	42.6N	125.5W							
46096	36.7N	123.0W							
46097	44.3N	124.1W							
46098	48.2N	127.9W							
46099	48.3N	129.0W							
46100	46.9N	130.4W							
46131	34.4N	119.7W							
46132	48.3N	122.6W							
46145	51.4N	129.9W							
46146	49.3N	123.7W							
46147	73.2N	140.8W							
46148	49.9N	123.7W							
46183	66.3N	140.0W							
46184	50.9N	140.8W							
46185	50.9N	140.8W							
46186	40.8N	126.7W							
46187	61.4N	146.7W							
46188	57.0N	146.3W							
46189	45.4N	125.3W							
46190	36.2N	122.0W							
46191	37.0N	122.5W							
46192	36.8N	122.0W							
46193	34.3N	119.8W							
46194	34.3N	120.5W							
46195	46.2N	124.1W							
46196	36.7N	121.9W							
46197	50.9N	144.8W							
46198	38.0N	123.5W							
46199	33.6N	119.0W							
46200	46.1N	130.2W							
46201	63.4N	148.1W							
46202	32.5N	117.2W							
46203	31.9N	116.6W							
46204	51.4N	131.0W							
46205	46.1N	131.1W							
46206	49.8N	137.3W							
46207	50.2N	127.9W							
46208	44.2N	125.8W							
46209	45.9N	130.2W							
46210	46.7N	124.2W							
46211	46.9N	124.2W							
46212	40.8N	124.6W							
46213	38.0N	123.5W							
46214	37.9N	122.5W							
46215	36.2N	121.9W							
46216	35.7N	121.4W							
46217	45.8N	123.9W							
46218	34.4N	119.8W							
46219	23.2N	158.1W							
46220	38.9N	123.7W							
46221	34.4N	118.0W							
46222	33.6N	117.5W							
46223	32.8N	117.2W							
46224	32.8N	117.2W							
46225	32.9N	117.4W							
46226	32.9N	117.4W							
46227	32.8N	117.3W							
46228	32.9N	117.4W							
46229	43.8N	124.5W							
46230	32.8N	117.3W							
46231	58.3N	136.8W							
46232	33.6N	118.0W							
46233	33.6N	118.0W							
46234	44.6N	124.9W							
46235	60.2N	146.8W							
46236	32.9N	117.4W							
46237	37.8N	122.6W							
46238	33.9N	118.6W							
46239	37.8N	122.7W							
46240	44.3N	124.9W							
46241	57.8N	152.5W							
46242	50.9N	140.8W							
46243	51.4N	131.0W							
46244	44.0N	069.1W							
46245	43.6N	068.9W							
46246	50.0N	145.0W							
46247	20.6N	157.0W							
46248	48.2N	088.4W							
46249	44.3N	063.6W							
46250	42.5N	070.8W							
46251	48.7N	126.5W							
46252	47.1N	090.7W							
46253	35.2N	120.8W							
46254	32.7N	079.9W							
46255	57.3N	133.6W							
46256	57.3N	137.5W							
46257	29.3N	090.5W							
46258	27.9N	093.6W							
46259	43.0N	070.6W							
46260	44.0N	066.1W							
46261	43.8N	068.9W							
46262	37.8N	122.7W							
46263	41.8N	124.4W							
46264	35.8N	121.9W							
46265	38.2N	123.3W							
46266	39.2N	124.0W							
46267	42.7N	124.8W							
46268	40.8N	124.5W							
46269	34.5N	120.7W							
46270	25.9N	089.7W							
46271	41.8N	124.4W							
46272	35.8N	121.9W							
46273	40.4N	124.5W							
46274	54.2N	165.8W							
46275	55.1N	163.1W							
51001	23.4N	162.2W							
51002	17.2N	157.8W							
51003	19.2N	160.8W							
51004	17.5N	157.5W							
ALRF1	25.0N	080.6W							
CHLV2	36.9N	075.7W							
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TOTAL FREQUENCY OF WIND SPEEDS (%)

BUOY	LAT	LONG	CALM	0-3KT	4-10KT	11-21KT	22-33KT	34-47KT	>47KT
41001	34.9N	072.9W		0.6	48.2	49.9	1.4		
41002	32.3N	075.3W		3.8	73.9	20.6	1.9		
41006	29.3N	077.3W		8.4	46.2	44.4	1.0		
42001	25.9N	089.7W		4.7	50.0	45.3			
42002	26.0N	093.6W		4.3	42.9	50.1	2.6		
42003	26.0N	085.9W		6.5	64.4	28.6	0.5		
42007	30.1N	088.9W		5.5	49.5	44.9	0.2		
44004	38.5N	070.7W		2.7	14.1	57.7	24.8	0.7	
44005	42.7N	068.3W		10.4	50.2	36.8	2.6		
44007	43.5N	070.1W		9.6	47.2	43.2			
44008	40.5N	069.5W	2.8	5.7	37.7	55.0	1.8	0.1	
44009	38.5N	074.6W	2.1	3.6	34.0	58.5	3.8	0.3	
44011	41.1N	066.6W		7.7	47.9	42.8	1.6		
44012	38.8N	074.6W	1.9	5.2	36.1	54.5	4.3		
44013	42.4W	070.8W	3.7	7.8	51.8	36.1	2.6		
45002	45.3N	086.3W	4.8	12.9	62.7	24.0	0.6		
45003	45.3N	082.8W		13.0	68.8	18.2			
45005	41.7N	082.4W		8.7	64.5	26.2	0.6		
45007	42.7N	087.1W	5.3	11.9	71.5	21.3			
45036	44.3N	082.4W	9.2	15.7	65.4	18.8	0.1		
46011	34.3N	148.3W		5.7	19.3	49.6	5.2		
46002	42.5N	130.3W		3.4	34.5	41.7	0.4		
46003	51.7N	155.7W		1.2	22.0	62.7	14.1		
46004	50.9N	135.7W		2.8	14.2	60.3	2.7		
46005	46.1N	130.9W		1.5	26.0	69.6	2.9		
46006	40.8N	137.6W		1.8	26.5	69.0	2.8		
46010	34.2N	120.7W		11.3	61.1	26.7	1.0		
46011	34.9N	120.9W		2.2	30.1	63.1	4.6		
46012	37.4N	122.7W		3.7	47.8	46.6	1.7		
46013	38.2N	127.3W		2.9	27.8	62.3	7.0		
46014	39.2N	124.0W		4.4	75.8	49.1	10.6		
46016	63.3N	177.3W		3.9	30.3	47.4	15.8	2.6	
46017	60.3N	172.3W		2.8	35.8	51.7	7.9	0.8	
46021	40.6N	124.5W		14.0	50.5	33.8	1.7		
46023	34.3N	120.7W		1.6	17.9	43.4	17.1		
46024	32.8N	119.5W		3.7	76.8	68.7	0.8		
46025	33.6N	119.0W		18.4	66.3	15.3			
46026	37.8N	122.7W		1.8	37.4	60.2	0.4		
46027	41.8N	124.4W	11.5	22.0	41.8	24.7	10.2	1.2	
46028	35.8N	121.9W		1.2	16.3	56.7	25.8		
46030	40.4N	124.5W	7.6	12.2	46.6	40.0	1.2		
46031	55.5N	161.7W		5.7	26.2	44.7	21.7	1.6	
46032	54.2N	165.2W			36.9	45.3	29.0		
46034	55.1N	167.1W			22.3	45.3	27.5	4.9	
51001	23.4N	162.3W		3.1	12.0	44.5	0.4		
51003	19.2N	160.8W		0.5	26.9	72.0	0.5		
51004	17.5N	152.4W		3.5	7.1	88.9	0.4		
ALFP1	25.0N	087.4W	3.3	11.3	59.2	25.2	0.8		
ALSN6	40.5N	073.8W	1.9	5.2	30.0	45.3	19.2	0.3	
BURL1	28.9N	089.4W	3.2	12.1	53.7	32.9	1.3		
CAR03	43.4N	124.7W	10.3	27.7	44.9	24.1	3.3		
CHLV2	36.9N	075.7W	1.2	3.9	30.9	54.6	8.6		
CLKV1	34.7N	076.5W	2.5	11.5	52.2	34.0			
CSBF1	29.7N	085.4W	7.8	23.9	62.7	12.9			
DBLN6	42.5N	070.4W	3.5	18.1	45.7	23.1	3.1		
DFSW1	47.7N	124.5W	4.5	17.1	55.4	23.0	0.1	0.4	
DISW3	47.1N	090.7W	3.2	13.0	49.7	32.2	4.0	0.3	
DSLW1	35.2N	077.7W	1.1	5.7	25.1	54.3	9.0	0.8	
FBIS1	32.7N	079.9W	2.4	13.9	59.0	24.6	0.6		
FFIA2	57.3N	132.6W	16.0	22.5	44.2	27.9	4.7	0.7	
FPSN7	33.5N	077.6W	2.1	6.6	33.9	48.6	10.9		
GTLL1	29.3N	094.7W	2.6	10.9	62.5	24.0			
GLLN6	43.9N	070.4W	2.6	10.4	45.1	43.3	1.0		
IOSN3	43.0N	070.6W	3.3	7.6	32.2	50.2	10.0		
LKWF1	26.6N	080.0W	3.3	17.1	65.0	17.9			
MDRM1	44.0N	068.1W	2.6	6.1	34.9	48.2	10.8		
MISW1	43.6N	068.9W		4.2	30.5	50.5	12.8		
NWPO1	44.6N	124.1W	7.9	28.1	47.8	23.1	1.1		
PILN4	48.2N	088.4W		2.7	62.2	32.4	2.7		
PTAC1	38.0N	123.7W	4.9	13.8	58.0	31.1	0.2		
PTAT2	27.9N	097.1W	2.4	9.8	34.8	54.9	2.5		
PTSC1	34.6N	120.7W	1.9	3.9	26.2	54.7	13.3		
ROAM4	47.9N	089.3W	2.6	12.8	32.1	39.7	15.4		
SPIO1	41.7N	082.4W	8.5	7.6	54.3	36.0	2.0		
SSNW3	43.8N	087.7W	6.3	11.6	41.3	41.0	5.6	0.1	
STSI1	48.3N	122.9W	5.4	24.7	49.1	23.3	2.9		
SALF1	30.4N	081.5W	3.0	10.5	51.5	33.6	2.6		
SRST2	29.7N	094.1W	1.7	6.9	47.1	44.7	1.3		
STDM4	47.2N	087.2W	1.3	5.4	28.2	50.3	15.7	0.3	
SVLS1	42.0N	080.7W	2.2	9.7	36.3	47.9	4.1		
TTIA1	48.4N	124.7W	9.1	17.8	52.6	22.3	6.5	0.8	
WPOW1	47.7N	122.4W	8.4	25.6	57.3	17.0	0.1		

TOTAL FREQUENCY OF WIND DIRECTIONS (%)

BUOY	N	NE	E	SE	S	SW	W	NW
41001	5.6	8.3	6.3	16.3	30.2	16.7	6.4	8.2
41002	9.0	10.2	7.2	19.0	18.5	24.2	8.4	3.5
41006	7.3	10.3	14.3	20.6	18.6	17.7	9.1	2.7
42001	9.2	8.7	9.9	45.1	17.5	7.7	7.7	4.2
42002	8.9	7.9	15.7	34.8	23.9	4.7	1.4	3.3
42003	7.9	11.5	38.6	17.0	10.0	3.4	5.9	5.6
42007	7.4	8.1	4.4	12.1	30.8	23.6	8.6	5.4
44004	10.0	10.5	8.7	9.1	16.0	26.9	12.4	9.4
44005	8.7	7.7	5.7	8.6	25.4	26.3	7.6	10.0
44007	11.8	13.2	6.9	9.1	28.9	20.6	4.6	7.9
44008	8.8	11.7	9.3	9.3	19.8	27.5	11.3	2.6
44009	10.9	12.4	8.5	9.6	16.6	9.5	6.4	8.2
44011	13.0	11.2	9.7	8.1	17.6	28.5	9.5	8.4
44012	8.4	10.6	8.6	10.4	41.2	9.6	7.9	5.3
44013	11.1	13.1	7.0	14.7	19.9	17.8	8.0	8.3
45002	9.0	5.4	5.5	5.3	12.2	19.0	8.0	15.7
45003	9.2	7.2	9.5	8.1	16.6	14.4	12.0	22.9
45005	6.2	19.0	12.5	7.0	19.4	26.1	6.9	3.9
45007	13.7	11.2	6.9	9.1	32.2	19.7	5.7	4.8
45036	15.1	14.1	7.7	14.1	21.1	10.8	7.7	9.5
46011	6.8	4.7	8.7	5.0	15.4	15.8	30.6	13.0
46002	17.5	2.7	0.2	4.9	10.3	9.7	17.0	37.8
46003	1.4	0.8	7.7	7.9	21.3	18.5	24.6	15.8
46004	12.7	8.3	2.5	3.8	15.4	12.9	22.3	23.1
46005	23.4	7.4	3.4	5.0	6.6	10.7	5.9	37.6
46006	24.6	2.9	3.3	9.2	7.2	7.4	19.6	25.7
46010	15.2	2.9	5.3	6.6	10.6	19.4	13.9	20.1
46011	6.3	0.2	0.4	0.7	2.0	1.9	3.8	84.7
46012	3.1	0.3	0.1	1.2	5.5	2.5	17.7	67.6
46013	0.3		0.1	5.2	2.0	3.4	12.9	77.0
46014	24.9	2.5	1.4	2.7	7.2	1.1	1.4	56.9
46016	15.9	26.1	7.5	13.6	11.2	12.6	5.5	5.7
46017	18.3	11.0	9.5	15.0	13.4	9.4	12.9	10.4
46021	52.7	5.0	2.8	2.8	9.7	7.2	7.8	10.4
46023	6.4			0.7	2.9	1.7	1.5	86.8
46024	3.2	0.5	0.5	0.3	0.6	2.8	16.7	75.4
46025	3.8	3.2	0.1	9.8	7.9	7.8	50.4	11.0
46026	6.1		0.1	2.3	0.6	0.6	54.5	27.7
46027	16.3	6.0	4.4	15.0	11.9	8.0	6.9	31.5
46028	6.1		0.9	6.2	2.2	0.1	2.0	82.5
46030	48.0	7.9	1.1	12.2	11.5	0.8	3.6	14.8
46031	30.2	3.2	1.5	2.7	31.6	21.9	4.2	4.9
46032	8.1	3.2	0.3	1.3	12.3	24.6	14.1	36.1
46034	8.1	1.1	1.2	71.8	14.2	4.0	14.6	25.0
51001	7.8	26.2	40.3	3.5	1.1	0.7	0.1	0.1
51003	4.2	30.5	58.9	6.3				0.2
51004	2.0	47.5	48.2	1.1	0.1			0.2
ALFP1	3.4	24.1	12.3	11.3	12.9	9.4		6.4
ALSN6	5.2	8.8	10.8	9.6	9.5	28.2	15.2	12.7
BURL1	10.1	7.7	15.8	18.4	22.5	15.0	3.0	7.5
CAR03	25.0	8.5	6.0	8.3	17.5	25.2	5.3	4.3
CHLV2	10.1	12.8	7.9	11.2	31.4	15.5	5.0	6.1
CLKV1	7.5	11.5	11.1	13.5	18.7	24.6	11.2	2.8
CSBF1	4.5	5.6	8.3	10.3	18.5	17.4	24.8	10.5
DBLN6	9.8	15.9	5.7	10.4	16.7	31.9	6.8	2.8
DFSW1	6.0	7.5	6.0	13.4	13.5	13.2	19.6	25.8
DISW3	10.0	32.6	13.1	7.2	7.1	19.2	5.8	5.0
DSLW1	6.5	10.4	17.8	11.8	13.7	23.1	8.9	7.9
FFIA2	16.1	7.8	5.0	21.8	20.2	14.4	10.1	4.5
FPSN7	9.3	14.2	9.5	17.0	17.9	25.1	7.9	6.9
GTLL1	12.3	7.3	8.8	18.4	26.2	17.8	6.2	4.9
GLLN6	11.4	11.4	2.4	7.2	27.5	12.7	19.5	8.3
IOSN3	8.5	17.5	6.2	10.6	25.1	14.2	9.1	8.8
LKWF1	4.9	12.8	19.2	11.8	16.5	11.1	14.1	11.7
MDRM1	6.9	7.7	10.8	6.5	19.5	26.6	10.1	11.9
MISW1	7.7	10.1	10.7	9.9	25.9	23.1	7.8	9.6
NWPO1	16.6	3.5	17.2	5.6	12.9	22.2	8.9	13.2
PILN4	6.4	22.0	20.6	22.3	7.1	3.7	7.1	10.8
PTAC1	61.0	15.3	2.4	1.5	10.1	0.6	0.3	9.9
PTAT2	4.7	8.4	17.0	53.7	8.3	1.7	1.7	4.6
PTSC1	65.7	1.1		0.3	7.5	1.0	0.4	24.1
ROAM4	6.4	36.9	15.1	10.9	8.0	0.6	5.8	8.3
SPIO1	6.1	16.0	16.3	9.2	13.4	23.3	7.1	8.7
SSNW3	17.5	8.6	4.3	8.4	35.9	13.1	9.5	2.7
STSI1	4.0	2.2	2.8	6.5	9.1	20.9	48.4	6.1
SALF1	2.1	14.4	18.8	19.0	10.4	18.4	9.1	7.1
SRST2	8.0	7.5	4.7	10.9	49.3	11.3	1.8	6.4
STDM4	11.6	7.9	13.5	18.6	15.2	7.7	10.2	15.3
SVLS1	4.8	1.0	4.0	13.7	29.9	20.8	17.9	8.7
TTIA1	1.6	11.3	13.3	9.6	18.5	27.9	17.6	4.2
WPOW1	18.3	28.2	1.9	6.6	30.6	5.1	0.2	1.3

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WAVE HEIGHTS (METERS)

BUOY	LAT	LONG	OBS	MAX	DY	HR	MEAN
41001	34.9N	072.9W	736	4.0	04	06	1.6
41002	32.3N	075.3W	515	3.5	04	08	1.6
41006	29.3N	077.3W	736	3.0	05	06	1.3
42001	25.9N	089.7W	236	1.5	03	14	0.7
42002	26.0N	093.6W	698	2.0	14	04	0.8
42003	26.0N	085.9W	725	1.5	03	07	0.6
42007	30.1N	088.9W	375	1.5	05	10	0.6
44004	38.5N	070.7W	712	4.5	04	06	1.6
44005	42.7N	068.3W	731	4.5	04	08	1.4
44007	43.5N	070.1W	654	2.0	10	03	0.9
44008	40.5N	069.5W	722	5.0	04	04	1.4
44011	41.1N	066.6W	738	5.0	04	09	1.7
45002	45.3N	082.8W	459	1.5	09	14	0.6
45005	41.7N	082.4W	421	2.5	17	19	0.7
45007	42.7N	087.1W	403	3.0	17	11	0.6
45036	44.3N	082.4W	440	1.5	01	14	0.6
46011	34.3N	148.3W	742	5.5	15	05	2.1
46002	42.5N	130.3W	740	4.0	16	07	2.0
46003	51.7N	155.7W	602	4.5	16	11	2.6
46004	50.9N	135.7W	740	4.5	15	15	2.1
46005	46.1N	130.9W	196	4.0	14	03	1.8
46006	40.8N	137.6W	741	4.0	02	22	1.8
46010	34.2N	124.2W	681	3.5	03	04	1.5
46011	34.9N	120.9W	742	3.5	04	07	1.7
46012	37.4N	122.7W	741	3.5	04	16	1.6
46013	38.2N	123.3W	706	4.5	15	07	1.8
46014	39.2N	124.0W	613	4.0	04	23	1.6
46022	40.8N	124.5W	735	5.0	15	00	1.7
46023	34.3N	120.7W	716	3.5	04	10	1.4
46024	32.8N	119.5W	737	3.5	04	11	1.8
46025	33.6N	119.0W	742	2.0	10	08	1.1
46026	37.8N	122.7W	737	3.0	05	03	1.4
46027	41.8N	124.4W	740	4.0	14	21	1.5
46028	35.8N	121.9W	578	3.5	15	05	1.9
51001	23.4N	162.3W	738	4.5	20	12	2.3
51002	17.2N	157.8W	741	4.0	11	10	2.4
51003	19.2N	160.8W	742	3.2	09	17	2.1
51004	17.5N	152.5W	741	3.5	20	22	2.4
CHLV2	36.9N	075.7W	724	3.0	04	01	0.9

FREQUENCY OF WAVE HEIGHTS (%)

BUOY	<1M	1-1.5M	2-2.5M	3-3.5M	4-5.5M	6-7.5M	8-9.5M	>9.5M
41001	1.2	60.5	34.9	2.1	1.0			
41002	0.9	57.0	37.2	4.6				
41006	1.3	62.3	21.0	7.0				
42001	0.7	83.2						
42002	0.8	55.9	0.1					
42003	0.6	76.6						
42007	0.6	80.8						
44004	1.6	56.4	35.9	2.5	1.1	0.5		
44005	1.4	65.3	19.7	7.1	1.5			
44007	0.9	69.2	1.5					
44008	1.4	72.2	17.7	0.9	1.1			
44011	1.7	53.1	35.7	6.2	1.2			
45002	0.6	78.9						
45005	0.7	69.1	27.1	2.1				
45007	0.6	76.9	19.3	2.2	1.4			
45036	0.6	75.2	24.7					
46011	1.6	38.9	37.7	16.4	5.6			
46002		34.1	58.9	6.5	0.2			
46003		29.8	47.4	20.2	2.2	0.7		
46004		47.0	31.3	14.3	6.7	0.5		
46005		52.0	38.7	8.6	0.5			
46006		34.7	38.7	7.8	1.6			
46010	1.3	70.0	23.0	5.5				
46011	0.4	74.0	48.6	6.9				
46012	1.4	62.6	29.5	6.3				
46013	0.8	49.7	33.1	14.4	1.8			
46014	2.1	62.1	24.3	10.6	0.8			
46022	1.2	62.6	24.3	9.6	2.1			
46023		42.7	49.3	7.9				
46024		45.5	48.5	5.8				
46025		87.6	4.3					
46026	7.0	68.7	23.6	0.5				
46027	4.3	65.8	24.1	4.3	1.3			
46028		71.6	62.2	6.0				
51001		13.2	66.3	18.1	2.1			
51002		13.6	49.9	36.3	0.1			
51003		17.7	73.4	8.7				
51004		3.9	74.3	21.7				
CHLV2	29.1	63.6	7.0	0.1				

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AIR TEMPERATURE (DEG C)

SQUARE	LAT	LONG	OBS	DAYS	MAX	IDY	HR	MIN	IDY	HR	MEAN
41JD18	34.3N	077.9W									
41JD28	32.3N	075.4W									
41JD48	29.3N	077.4W									
42JD28	26.3N	093.5W									
42JD38	25.3N	085.5W									
42JD48	24.3N	076.4W									
42JE17	37.4N	018.9W									
42JE28	36.3N	032.7W									
42JE38	35.3N	047.5W									
42JE48	34.3N	062.4W									
42JE58	33.3N	077.3W									
43JD28	42.3N	069.4W									
43JD38	42.3N	070.4W									
43JD48	42.3N	059.4W									
43JE38	42.3N	034.4W									
43JE48	42.3N	049.4W									
43JE58	42.3N	064.4W									
43JE68	42.3N	079.4W									
44JD28	46.3N	069.4W									
44JD38	46.3N	054.4W									
44JD48	46.3N	039.4W									
44JE38	46.3N	024.4W									
44JE48	46.3N	009.4W									
45JD38	50.3N	054.4W									
45JD48	50.3N	039.4W									
45JE38	50.3N	024.4W									
45JE48	50.3N	009.4W									
46JD38	54.3N	054.4W									
46JD48	54.3N	039.4W									
46JE38	54.3N	024.4W									
46JE48	54.3N	009.4W									
47JD38	58.3N	054.4W									
47JD48	58.3N	039.4W									
47JE38	58.3N	024.4W									
47JE48	58.3N	009.4W									
48JD38	62.3N	054.4W									
48JD48	62.3N	039.4W									
48JE38	62.3N	024.4W									
48JE48	62.3N	009.4W									
49JD38	66.3N	054.4W									
49JD48	66.3N	039.4W									
49JE38	66.3N	024.4W									
49JE48	66.3N	009.4W									
50JD38	70.3N	054.4W									
50JD48	70.3N	039.4W									
50JE38	70.3N	024.4W									
50JE48	70.3N	009.4W									
51JD38	74.3N	054.4W									
51JD48	74.3N	039.4W									
51JE38	74.3N	024.4W									
51JE48	74.3N	009.4W									
52JD38	78.3N	054.4W									
52JD48	78.3N	039.4W									
52JE38	78.3N	024.4W									
52JE48	78.3N	009.4W									

SEA TEMPERATURE (DEG C)

SQUARE	DAYS	MAX	IDY	HR	MIN	IDY	HR	MEAN
41JD18	30	28.9134	201	22.5102	091	23.91
41JD28	30	29.7134	201	24.6101	191	26.81
41JD48	30	29.8106	231	25.6101	121	27.21
42JD28	30	31.4109	021	27.6101	081	28.71
42JD38	30	31.4107	021	27.1101	111	28.41
42JD48	30	28.8105	201	27.6115	001	28.61
42JE17	26	27.5103	171	20.0111	081	23.31
42JE28	30	15.3122	201	09.5102	051	11.51
42JE38	25	12.5129	161	07.7130	071	11.51
42JE48	30	15.2122	201	09.8114	121	12.11
42JE58	30	21.6129	161	14.9101	001	19.11
43JD28	30	16.3129	201	04.5108	021	10.81
43JD38	30	21.3119	211	14.9104	101	18.51
43JD48	30	19.3120	201	11.3115	111	13.31
43JE28	30	12.0129	051	03.1106	111	05.71
43JE38	30	09.9130	221	02.9101	001	03.41
43JE48	30	21.1109	021	15.0101	091	17.91
43JE58	27	03.5128	231	03.0130	101	03.21
44JD28	30	14.4130	201	03.9101	001	08.01
44JD38	30	17.3130	171	03.9101	011	07.11
44JD48	30	19.4129	221	08.7103	131	07.61
44JE38	30	15.6112	231	12.4101	141	13.71
44JE48	30	14.9130	011	09.0101	001	08.11
44JE58	30	11.3107	091	08.2105	221	09.31
45JD38	30	13.5118	001	10.5101	031	12.31
45JD48	30	18.1119	001	13.7130	151	14.71
45JE38	30	17.9111	191	09.5128	121	13.61
45JE48	30	13.7112	221	10.4109	081	11.61
45JE58	30	15.5105	221	12.0113	161	13.51
46JD38	30	15.3122	061	09.2101	091	10.81
46JD48	30	15.5106	021	09.4112	151	11.71
46JE38	30	15.7108	001	09.4124	181	11.51
46JE48	30	17.7123	011	11.1105	111	13.91
46JE58	30	18.4123	021	14.5103	131	15.41
47JD38	30	20.2130	231	14.9103	071	17.31
47JD48	30	15.9127	221	11.1103	081	13.41
47JE38	30	17.9104	231	08.2129	061	10.71
47JE48	30	16.8122	011	11.5109	031	13.91
47JE58	30	13.0122	231	09.2127	111	10.81
48JD38	30	09.3126	041	07.9101	001	08.61
48JD48	30	09.1130	041	06.7101	171	08.01
48JE38	30	27.0117	081	23.8101	161	25.41
48JE48	30	26.3128	011	24.3107	081	25.21
48JE58	30	27.0128	051	24.6103	161	25.71
49JD38	30	25.9127	011	24.9115	171	25.11
49JD48	30	30.7111	201	27.5101	111	29.01
49JE38	30	23.9112	011	19.9101	001	21.41
49JE48	30	27.5129	221	23.5113	151	24.61
49JE58	30	32.1126	231	25.2114	041	28.31
50JD38	29	29.5106	211	27.2101	091	28.01
50JD48	15	28.5127	051	24.6101	171	26.81

AIR-SEA TEMPERATURE DIFFERENCE (DEG C)

SQUARE	OBS	DAYS	MAX	IDY	HR	MIN	IDY	HR	MEAN
41JD18									
41JD28									
41JD48									
42JD28									
42JD38									
42JD48									
42JE17									
42JE28									
42JE38									
42JE48									
42JE58									
43JD28									
43JD38									
43JD48									
43JE28									
43JE38									
43JE48									
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51JE38									
51JE48									
51JE58									
52JD38									
52JD48									
52JE38									
52JE48									
52JE58									

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PRESSURE (MB)

SQUARE	LAT	LONG	OBS	DAYS	MAX	IDY	HR	MIN	IDY	HR	MEAN
41JD18	34.3N	077.9W	719	30	1021.2172	131		1006.8113	101		1014.81
41JD28	32.3N	075.4W	717	30	1021.5172	161		1011.1113	091		1017.31
41JD48	29.3N	077.4W	716	30	1023.1117	151		1012.8127	081		1018.21
42JD28	26.3N	093.5W	663	30	1019.5130	161		1006.4115	081		1014.31
42JD38	25.3N	085.5W	72	30	1020.4118	241		1012.9115	091		1016.21
42JD48	24.3N	076.4W	716	30	1021.5173	161		1011.5172	151		1016.41
42JE17	37.4N	018.9W	561	26	1024.1122	131		1003.6179	081		1014.31
42JE28	36.3N	032.7W	719	30	1024.0123	131		999.3112	191		1012.51
42JE38	35.3N	047.5W	296	30	1024.9110	201		1005.1126	141		1014.81
42JE48	34.3N	062.4W	717	30	1024.1173	131		1000.0112	201		1012.51
42JE58	33.3N	077.3W	716	30	1024.7122	111		1001.3132	191		1014.21
43JD28	41.3N	069.4W	719	30	1024.4123	141		1000.1112	161		1013.61
43JD38	42.3N	070.4W	717	30	1024.4172	121		1003.0112	181		1013.91
43JD48	42.3N	059.4W	719	30	1024.1130	211		998.1101	161		1012.01
43JE38	42.3N	034.4W	716	30	1024.0170	151		984.2101	001		1013.91
43JE48	42.3N	049.4W	719	30	1024.9171	161		989.8101	091		1012.61
43JE58	41.3N	064.4W	716	30	1027.4175	131		999.2101	081		1014.41
43JE68	41.3N	079.4W	267	24	1026.6170	141		1012.6127	201		1021.31
44JD28	46.3N	069.4W	719	30	1027.5106	141		1001.3199	061		1014.91
44JD38	46.3N	054.4W	716	30	1027.2171	161		997.2101	001		1012.81
44JD48	46.3N	039.4W	719	30	1029.0123	121		986.7103	091		1012.51
44JE38	46.3N	024.4W	719	30	1030.0108	171		1004.8106	101		1021.01
44JE48	46.3N	009.4W	720	30	1029.9172	181		985.5179	141		1013.21
45JD38	50.3N	054.4W	716	30	1029.6173	231		997.9103	001		1018.71
45JD48	50.3N	039.4W	716	30	1029.4175	131		999.2101	081		1014.41
45JE38	50.3N	024.4W	716	30	1029.6170	141		1012.6127	201		1021.31
45JE48	50.3N	009.4W	716	30	1029.5106	141		1001.3199	061		1014.91
46JD38	54.3N	054.4W	716	30	1029.2171	161		992.2101	001		1012.81
46JD48	54.3N	039.4W	719	30	1029.0123	121		986.7103	091		1012.51
46JE38	54.3N	024.4W	719	30	1030.0108	171		1004.8106	101		1021.01
46JE48	54.3N	009.4W	720	30	1029.9172	181		985.5179	141		1013.21
46JE58	53.3N	024.4W	716	30	1029.6173	231		997.9103	001		1018.71
47JD38	58.3N	054.4W	716	30	1029.4175	131		999.2101	081		1014.41
47JD48	58.3N	039.4W	716	30	1029.6170	141		1012.6127	201		1021.31
47JE38	58.3N	024.4W	716	30	1029.5106	141		1001.3199	061		1014.91
47JE48	58.3N	009.4W	716	30	1029.2171	161		992.2101	001		1012.81
48JD38	62.3N	054.4W	719	30	1029.0123	121		986.7103	091		1012.51
48JD48	62.3N	039.4W	719	30	1030.0108	171		1004.8106	101		1021.01
48JE38	62.3N	024.4W	720	30	1029.9172	181		985.5179	141		1013.21
48JE48	62.3N	009.4W	716	30	1029.6173	231		997.9103	001		1018.71
48JE58	62.3N	024.4W	716	30	1029.4175	131		999.2101	081		1014.41
49JD38	66.3N	054.4W	716	30	1029.6170	141		1012.6127	201		1021.31
49JD48	66.3N	039.4W	716	30	1029.5106	141		1001.3199	061		1014.91
49JE38	66.3N	024.4W	716	30	1029.2171	161		992.2101	001		1012.81
49JE48	66.3N	009.4W	719	30	1029.0123	121		986.7103	091		1012.51
49JE58	66.3N	024.4W	719	30	1030.0108	171		1004.8106	101		1021.01
50JD38	70.3N	054.4W	716	30	1029.6173	231		997.9103	001		1018.71
50JD48	70.3N	039.4W	716	30	1029.4175	131		999.2101	081		1014.41
50JE38	70.3N	024.4W	716	30	1029.6170	141		1012.6127	201		1021.31
50JE48	70.3N	009.4W	716	30	1029.5106	141		1001.3199	061		1014.91
50JE58	70.3N	024.4W	716	30	1029.2171	161		992.2101	001		1012.81
51JD38	74.3N	054.4W	716	30	1029.0123	121		986.7103	091		1012.51
51JD48	74.3N	039.4W	719	30	1030.0108	171		1004.8106	101		1021.01
51JE38	74.3N	024.4W	720	30	1029.9172	181		985.5179	141		1013.21
51JE48	74.3N	009.4W	716	30	1029.6173	231		997.9103	001		1018.71
51JE58	74.3N	024.4W	716	30	1029.4175	131		999.2101	081		1014.41
52JD38	78.3N	054.4W	716	30	1029.6170	141		1012.6127	201		1021.31
52JD48	78.3N	039.4W	716	30	1029.5106	141		1001.3199	061		1014.91
52JE38	78.3N	024.4W	716	30	1029.2171	161		992.2101	001		1012.81
52JE48	78.3N	009.4W	719	30	1029.0123	121		986.7103	091		1012.51
52JE58	78.3N	024.4W	719	30	1030.0108	171		1004.8106	101		1021.01

#TWO SPEEDS (KNOTS)

SQUARE	MAX	IDY	HR	DIR
41JD18	25116	231	210	
41JD28	24113	061	230	
41JD48	23114	061	240	
42JD28	31117	201	230	
42JD38	40114	141	170	
42JD48	23111	121	220	
42JE17	43101	121	180	
42JE28	24102	141	190	
42JE38	24101	101	180	
42JE48	27127	091	030	
42JE58	24127	091	030	
43JD28	43101	121	190	
43JD38	25125	091	020	
43JD48	25127	091	020	
43JE28	25103	091	020	
43JE38	29127	101	030	
43JE48	25127	091	220	
43JE58	27102	091	140	
44JD28	25103	001	170	
44JD38	25107	031	020	
44JD48	25109	221	310	
44JE38	30115	141	130	
44JE48	30119	081	310	
44JE58	27127	041	040	
45JD38	25109	221	310	
45JD48	30115	141	130	
45JE38	30119	081	310	
45JE48	27127	041	040	
45JE58	24102	091	140	
46JD38	25103	001	170	
46JD48	25107	031	020	
46JE38	25109	221	310	
46JE48	30115	141	130	
46JE58	30119	081	310	
47JD38	27127	041	040	
47JD48	24102	091	140	
47JE38	25103	001	170	
47JE48	25107	031	020	
47JE58	25109	221	310	
48JD38	30115	141	130	
48JD48	30119	081	310	
48JE38	27127	041	040	
48JE48	24102	091	140	
48JE58	25103	001	170	
49JD38	25107	031	020	
49JD48	25109	221	310	
49JE38	30115	141	130	
49JE48	30119	081	310	
49JE58	27127	041	040	
50JD38	24102	091	140	
50JD48	25103	001	170	
50JE38	25107	031	020	
50JE48	25109	221	310	
50JE58	30115	141	130	
51JD38	30119	081	310	
51JD48	27127	041	040	
51JE38	24102	091	140	
51JE48	25103	001	170	
51JE58	25107	031	020	
52JD38	25109	221	310	
52JD48	30115	141	130	
52JE38	30119	081	310	
52JE48	27127	041	040	
52JE58	24102	091	140	

MEAN WIND SPEED (KNOTS)

SQUARE	E	SE	S	SW	W	NW	TOTAL
41JD18	9.61	8.21	7.31	7.51	10.21	12.01	11.31	8.81	09.61
41JD28	9.41	8.41	7.61	8.01	9.61	11.21	10.31	8.61	10.61
41JD48	8.41	9.11	8.31	7.61	10.81	11.21	10.01	8.61	10.81
42JD28	9.11	10.51	12.21	14.91	11.91	10.61	8.21	9.21	13.31
42JD38	7.01	8.41	6.61	10.31	10.31	10.11	11.31	10.21	09.51
42JD48	7.81	9.31	9.61	8.21	9.41	10.01	9.51	7.61	09.31
42JE17	16.31	12.21	7.71	8.11	15.31	13.31	12.31	12.01	12.81
42JE28	10.11	11.61	7.91	9.11	10.81	9.91	8.71	8.61	09.81
42JE38	11.21	09.91	6.31	6.31	9.11	9.61	8.31	7.61	10.31
42JE48	9.71	7.21	6.11	10.11	11.31	9.31	10.61	8.61	09.71
42JE58	25125	091	020	11.81	10.31	6.81	8.51	12.31	9.61	9.91	7.11	10.21
43JD28	25127	191	020	10.11	7.91	5.71	6.01	9.31	8.11	8.31	9.41	08.41
43JD38	25103	091	020	12.71	8.01	6.81	8.11	8.71	10.31	9.61	10.81	09.91
43JD48	29127	101	030	13.41	11.81	6.11	7.81	9.91	8.51	11.61	9.21	10.01
43JE28	25127	091	220	4.61	4.61	5.81	5.71	6.41	8.11	6.21	6.31	06.81
43JE38	25103	091	020	12.71	10.31	5.11	6.91	7.71	8.11	9.71	9.11	08.61
43JE48	24102	091	140	11.91	7.81	4.01	13.91	11.51	12.31	10.51	12.11	11.41
43JE58	25103	001	170	12.51	7.51	6.71	7.31	15.11	12.31	10.31	14.51	12.21
44JD28	25107	031	020	13.11	14.91	10.71	14.01	12.11	12.31	9.51	10.71	12.61
44JD38	25109	221	310	8.41	3.81	4.41	1.01	7.91	5.71	4.71	14.71	13.31
44JD48	25109	221	310	8.41	3.81	4.41	1.01	7.91	5.71	4.71	14.71	13.31
44JE38	30115	141	130	8.71		2.61	7.11	7.41	9.31	4.51	10.01	08.21
44JE48	30119	081	310	8.71		2.61	7.11	7.41	9.31	4.51	10.01	08.21
44JE58	27127	041	040	13.81	3.41	3.41	4.51	6.21	6.21	4.21	13.31	13.31
45JD38	25109	221	310	8.41	3.81	4.41	1.01	7.91	5.71	4.71	14.71	13.31
45JD48	30115	141	130	8.71		2.61	7.11	7.41	9.31	4.51	10.01	08.21
45JE38	30119	081	310	8.71		2.61	7.11	7.41	9.31	4.51	10.01	08.21
45JE48	27127	041	040	13.81	3.41	3.41	4.51	6.21	6.21	4.21	13.31	13.31
45JE58	24102	091	140	12.51	11.51	9.81	9.01	11.91	10.01	8.61	9.51	10.71
46JD38	25103	001	170	12.51	11.51	9.81	9.01	11.91	10.01	8.61	9.51	10.71
46JD48	25107	031	020	13.11	14.91	10.71	14.01	12.11	12.31	9.51	10.71	12.61
46JE38	25109	221	310	8.41	3.81	4.41	1.01	7.91	5.71	4.71	14.71	13.31
46JE48	30115	141	130	8.71		2.61	7.11	7.41	9.31	4.51	10.01	08.21
46JE58	30119	081	310	8.71		2.61	7.11	7.41	9.31	4.51	10.01	08.21
47JD38	27127	041	040	13.81	3.41	3.41	4.51	6.21	6.21	4.21	13.31	13.31
47JD48	24102	091	140	12.51	11.51	9.81	9.01	11.91	10.01	8.61	9.51	10.71
47JE38	25103	001	170	12.51	11.51	9.81	9.01	11.91	10.01	8.61	9.51	10.71
47JE48	25107	031	020	13.11	14.91	10.71	14.01	12.11	12.31	9.51	10.71	12.61
47JE58	25109	221	310	8.41	3.81	4.41	1.01	7.91	5.71	4.71	14.71	13.31
48JD38	30115	141	130	8.71		2.61	7.11	7.41	9.31	4.51	10.01	08.21
48JD48	30119	081	310	8.71		2.61	7.11	7.41	9.31	4.51	10.01	08.21
48JE38	27127	041	040	13.81	3.41	3.41	4.51	6.21	6.21	4.21	13.31	13.31
48JE48	24102	091	140	12.51	11.51	9.81	9.01	11.91	10.01	8.61	9.51	10.71
48JE58	25103	001	170	12.51	11.51	9.81	9.01	11.91	10.01	8.61	9.51	10.71
49JD38	25107	031	020	13.11	14.91	10.71	14.01	12.11	12.31	9.51	10.71	12.61
49JD48	25109	221	310	8.41	3.81	4.41	1.01	7.91	5.71	4.71	14.71	13.31
49JE38	30115	141	130	8.71		2.61	7.11	7.41	9.31	4.51	10.01	08.21
49JE48	30119	081	310	8.71		2.61	7.11	7.41	9.31	4.51	10.01	08.21
49JE58	27127	041	040	13.81	3.41	3.41	4.51	6.21	6.21	4.21	13.31	13.31
50JD38	24102	091	140	12.51	11.51	9.81	9.01	11.91	10.01	8.61	9.51	10.71
50JD48	25103	001	170	12.51	11.51	9.81	9.01	11.91	10.01	8.61	9.51	10.71
50JE38	25107	031	020	13.11	14.91	10.71	14.01	12.11	12.31	9.51	10.71	12.61
50JE48	25109	221	310	8.41	3.81	4.41	1.01	7.91	5.71	4.71	14.71	13.31
50JE58	30115	141	130	8.71		2.61	7.11	7.41	9.31	4.51	10.01	08.21
51JD38	30119	081	310	8.71		2.61	7.11	7.41	9.31	4.51	10.01	08.21
51JD48	27127	041	040	13.81	3.41	3.41	4.51	6.21	6.21	4.21	13.31	13.31
51JE38	24102	091	140	12.51	11.51	9.81	9.01	11.91	10.01	8.61	9.51	10.71
51JE48	25103	001	170	12.51	11.51	9.81	9.01	11.91	10.01	8.61	9.51	10.71
51JE58	25107	031	020	13.11	14.91	10.71	14.01	12.11	12.31	9.51	10.71	12.61
52JD38	25109	221	310	8.41	3.81	4.41	1.01	7.91	5.71	4.71	14.71	13.31
52JD48	30115	141	130	8.71		2.61	7.11	7.41	9.31	4.51	10.01	08.21
52JE38	30119	081	310	8.71		2.61	7.11	7.41	9.31	4.51	10.01	08.21
52JE48	27127	041	040	13.81	3.41	3.41	4.51	6.21	6.21	4.21	13.31	13.31
52JE58	24102	091	140	12.51	11.51	9.81	9.01	11.91	10.01	8.61	9.51	10.71

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TOTAL FREQUENCY OF WIND SPEEDS (%)

BUOY	LAT	LONG	CALM	1-3KT	4-10KT	11-21KT	22-33KT	34-47KT	>47KT
41001	34.9N	072.9W		0.4	50.1	39.1	1.4		
41002	32.3N	075.4W		1.8	45.5	43.2	3.4	0.1	
41006	29.3N	077.6W		1.0	45.7	47.0	0.4		
42002	26.0N	093.6W		2.3	27.1	47.7	2.9		
42 039	28.7N	086.0W		1.9	76.4	6.8	0.1		
42007	30.1N	088.8W		1.1	57.3	35.4	0.3		
44004	38.5N	070.7W		0.1	35.4	47.8	11.0		
44005	42.7N	068.4W		0.1	55.6	35.2	1.1		
44007	43.5N	070.1W	0.7	4.5	46.1	49.1			
44008	40.5N	069.5W	2.4	2.9	60.8	33.3	1.0		
44009	38.5N	074.6W	4.8	6.4	49.1	43.5	1.0		
44011	41.1N	066.6W		0.8	64.4	25.7	0.8		
44014	36.6N	074.8W	2.1	5.1	50.8	43.1	1.0		
44012	42.4N	070.9W	2.5	5.9	55.7	35.7	1.1		
45002	45.3N	068.9W	4.7	13.2	73.8	12.6	0.3		
45003	45.3N	083.8W		8.5	67.5	23.6	0.4		
45005	41.7N	082.4W		7.4	56.7	35.5	0.4		
45006	47.3N	090.7W	18.9	26.9	56.0	7.1			
45007	42.7N	087.1W	5.6	11.8	76.1	12.1			
45008	44.3N	082.4W	9.6	19.9	63.8	16.1	0.1		
46011	36.3N	120.3W		3.1	33.3	56.3	7.3		
46022	40.5N	130.3W		2.6	31.1	62.4	4.2		
46023	34.7N	120.7W		3.4	28.4	63.7	4.5		
46024	50.9N	145.9W		7.7	35.9	54.3	2.1		
46025	46.1N	131.0W		3.8	37.4	56.3	2.5		
46006	40.8N	137.4W		4.8	30.0	63.7	1.5		
46101	48.2N	124.7W		7.0	49.3	43.7			
46011	34.9N	120.9W		0.4	23.8	67.1	4.8		
46012	37.4N	122.7W		14.9	52.3	32.8			
46013	38.2N	123.3W		2.2	34.0	53.8	9.0		
46014	39.2N	124.0W		1.2	33.6	61.4	3.8		
46016	63.3N	171.1W	0.8	7.5	45.6	44.8	2.1		
46017	60.5N	147.3W		10.9	51.3	34.0	3.8		
46021	60.5N	146.8W		9.3	52.2	36.1	2.4		
46023	34.3N	120.7W		9.2	35.8	49.0	5.9		
46024	32.6N	119.5W		14.0	45.4	39.5	0.3		
46025	33.6N	119.0W		2.2	66.6	9.3			
46026	37.9N	122.7W		10.0	53.7	35.3	1.0		
46027	41.8N	124.4W	14.9	27.9	46.1	26.0			
46028	35.8N	121.9W		12.1	35.3	41.4	11.2		
46031	41.4N	124.5W	9.1	7.6	38.9	43.5			
46311	55.5N	161.7W		5.0	25.4	58.3	11.3		
46312	54.2N	165.8W		0.4	36.0	46.9	16.7		
46314	58.1N	163.1W			23.2	57.5	19.3		
51001	23.4N	162.3W		5.9	56.9	37.2			
51003	19.2N	160.8W		2.2	57.2	40.6			
51004	17.5N	152.5W			7.6	92.4			
ALRF1	25.4N	067.6W	2.9	8.1	57.2	33.7	1.0		
ALSN6	40.5N	073.8W	1.4	4.1	35.6	51.3	8.9		
BURL1	28.9N	089.4W	3.6	17.6	46.3	33.2	2.8		
CAPE31	43.3N	124.4W	8.1	20.1	35.2	34.3	4.4		
CHLV2	36.5N	075.7W	1.0	6.0	36.6	52.3	4.6		
CLKN7	29.6N	096.7W	1.1	6.9	47.0	42.9	1.3		
CSBF1	29.7N	085.4W	5.9	27.7	60.7	11.7			
DBLN6	42.5N	079.4W	4.1	12.6	52.5	29.6	5.2		
DESW1	47.7N	124.5W	3.3	20.9	39.5	36.4	3.1		
DISW3	47.1N	090.7W	5.7	15.1	47.0	33.5	4.6		
DSLN7	35.2N	075.5W	1.1	4.5	33.2	46.1	15.7	0.4	
FBIS1	32.7N	079.9W	2.1	13.7	54.6	31.0	0.7		
FFIA2	57.3N	133.6W	17.9	26.7	46.0	25.7	1.6		
FPSM7	33.5N	077.6W	3.1	8.7	41.2	41.6	6.4	0.1	
GDIL1	29.3N	089.9W	3.3	11.0	47.6	31.2	6.6		
GLLN6	43.9N	075.4W	2.0	11.5	47.9	37.2	2.8		
IOSN3	43.0N	072.6W	0.9	3.6	31.3	60.8	4.4		
LPWF1	26.6N	080.0W	1.7	14.5	65.9	19.6			
MDHM1	44.3N	068.1W	0.6	3.1	20.9	62.8	11.5	1.7	
MISM1	43.2N	064.9W		2.4	20.4	62.8	13.8	0.6	
NWPO1	44.6N	124.1W	12.2	28.6	40.3	24.1	7.1		
PILM4	48.2N	068.4W	3.4	8.4	42.5	41.6	7.4	0.1	
PTAC1	39.1N	123.7W	11.4	20.0	46.1	32.9	0.7		
PTAT2	27.8N	097.1W	1.3	3.9	35.1	56.6	2.4		
PTGC1	29.0N	094.4W	1.7	21.9	43.1	31.2	2.1		
ROAM1	47.9N	089.7W	1.4	5.3	31.7	43.3	19.2	0.4	
SBIO1	41.7N	082.8W	17.3	10.6	62.7	22.9	3.6		
SGNW3	43.8N	087.7W	7.7	18.5	49.3	26.7	3.4		
SISW1	48.3N	122.9W	2.2	17.5	48.9	30.4	2.8		
SJNF1	30.4N	081.4W	2.2	8.8	70.8	19.9			
SRST2	29.7N	094.1W	0.7	6.0	44.5	48.6	0.9		
STDM4	47.2N	087.2W	1.0	4.7	21.5	48.1	24.4	1.3	
SVLS1	32.0N	080.7W	0.8	7.4	36.7	48.9	6.7	0.1	
TTIW1	48.4N	124.7W	0.1	14.8	51.3	31.5	2.4		
WPOW1	47.7N	122.4W	9.2	14.3	51.6	18.1			

TOTAL FREQUENCY OF WIND DIRECTIONS (%)

BUOY	N	NE	E	SE	S	SW	W	NW
41001	7.7	7.4	15.5	12.9	16.0	27.8	6.6	6.2
41002	2.1	12.6	10.9	7.4	13.0	38.8	10.6	3.8
41006	3.0	7.2	10.8	9.6	17.7	35.4	13.6	2.6
42002	4.5	4.5	18.9	15.8	11.4	0.7	3.4	3.8
42 039	5.9	20.5	19.6	22.2	16.0	3.4	6.6	5.9
42007	5.3	6.5	9.6	9.1	17.6	22.0	15.6	14.3
44004	10.1	5.0	3.8	7.2	14.3	18.6	29.1	12.8
44005	7.9	6.3	4.0	5.3	20.8	25.5	18.7	11.5
44007	27.8	27.5	13.5	11.0	9.6	2.5	5.6	2.5
44008	7.2	4.8	5.6	6.0	22.2	23.9	20.4	9.9
44009	8.7	7.6	6.3	11.5	30.8	14.4	12.3	8.4
44011	6.9	6.6	2.3	7.0	19.7	29.2	20.3	8.1
44014	7.6	9.0	6.9	9.9	15.4	13.6	12.9	6.7
44012	7.9	10.6	6.7	12.3	16.9	17.9	21.8	7.9
45002	6.8	3.4	3.1	7.3	10.1	36.1	17.3	15.9
45003	5.3	3.5	7.4	7.1	16.3	10.3	15.9	34.2
45005	9.3	19.6	16.7	7.3	12.3	19.4	20.0	5.4
45006	13.4	40.2	5.1	1.2		6.3	18.5	15.5
45007	12.3	10.4	9.0	14.7	15.5	14.2	14.8	9.0
45008	14.7	9.7	5.9	12.9	16.9	9.0	17.3	13.9
46011	3.8	3.9	13.4	19.6	14.1	15.1	21.3	8.9
46022	44.5	6.6	1.0	4.5	7.7	14.6	11.6	7.6
46023	8.3	6.8	3.1	3.4	9.8	18.8	42.2	11.6
46024	6.1	4.5	3.3	13.4	16.0	23.7	22.9	9.9
46025	14.5	6.7	5.3	2.5	7.7	21.3	12.3	29.7
46006	11.6	19.9	7.8	11.1	10.3	21.7	7.9	9.8
46101	23.5	2.8	4.9	3.5	15.1	5.1	8.1	37.3
46011	8.4	0.6	4.4	0.4	3.2	1.7	2.5	80.9
46012	8.4		0.2	4.7	22.6	7.2	10.6	49.8
46013	5.2	1.4	2.4	8.2	4.7	2.7	16.0	61.3
46014	46.0	2.1	1.8	5.0	12.7	4.0	1.9	26.6
46016	12.7	24.9	6.9	9.1	13.2	15.9	6.3	11.1
46017	22.0	14.4	15.4	7.8	13.6	16.3	4.5	5.7
46021	6.3	3.3	1.0	1.8	12.9	5.9	1.5	10.3
46023	7.8	1.7	0.7	3.5	5.6	4.2	5.4	71.1
46024	5.2	1.8	2.9	5.4	2.3	3.4	26.4	54.6
46025	1.4	1.5	5.5	11.0	10.1	10.7	30.6	9.2
46026	8.4	7.5	3.7	22.6	17.2	4.5	11.0	25.0
46027	7.9	0.5	1.5	9.6	8.6	1.3	4.2	66.3
46028	56.6	3.6	0.1	10.5	21.4	0.9	1.3	5.6
46031	40.7	11.5	0.9	2.8	26.1	14.9	1.1	1.9
46312	17.1	3.1	7.7	19.4	12.0	4.1	7.5	30.4
46314	16.9	2.2	2.5	31.5	10.1	0.2	6.5	30.0
51001	9.1	48.9	30.2	2.4	2.7	2.0	0.5	0.2
51003		41.0	55.3	3.6				
51004	0.2	62.6	37.2					
ALRF1	8.2	8.8	27.1	27.8	15.5	9.7	7.6	2.4
ALSN6	6.5	12.1	4.6	5.4	8.5	24.3	17.6	20.9
BURL1	3.7	9.6	12.3	14.6	27.1	17.9	9.5	5.2
CAPE31	39.3	21.6	4.6	4.3	13.3	13.0	1.1	2.9
CHLV2	5.3	9.5	8.2	13.1	29.9	19.3	6.9	7.6
CLKN7	9.1	8.1	13.1	14.4	11.4	34.9	10.5	3.6
CSBF1	3.0	8.8	5.8	5.7	16.5	26.4	25.1	9.1
DBLN6	7.8	11.0	6.3	9.6	13.4	38.4	9.3	4.1
DESW1	14.9	7.1	5.4	7.0	10.1	9.7	8.1	48.6
DISW3	7.3	7.8	13.1	7.0	8.3	31.4	13.1	7.7
DSLN7	8.2	8.4	9.0	13.2	10.4	34.5	13.1	3.2
FBIS1	2.6	3.9	13.1	11.2	10.7	30.3	19.5	8.7
FFIA2	13.9	12.3	1.9	23.4	20.9	13.3	7.3	7.1
FPSM7	0.9	13.1	10.3	8.0	8.8	29.4	11.3	9.2
GDIL1	5.5	5.9	9.4	15.8	25.0	22.2	9.2	7.5
GLLN6	7.5	12.0	4.9	9.0	15.4	19.6	26.2	5.3
IOSN3	8.9	10.5	3.0	10.9	21.2	16.5	21.2	7.7
LPWF1	0.9	14.0	11.7	16.9	24.5	10.6	15.5	5.7
MDHM1	5.0	13.5	6.0	6.2	16.2	25.4	17.9	7.8
MISM1	4.0	10.7	3.8	4.8	18.6	29.9	15.0	7.6
NWPO1	39.0	6.8	13.5	1.4	11.4	10.4	5.6	11.9
PILM4	4.2	13.6	14.6	11.0	11.3	16.7	22.3	5.9
PTAC1	49.2	8.3	2.0	3.6	17.8	2.5	3.2	13.2
PTAT2	4.2	7.4	22.5	50.7	7.8	0.2	1.6	3.6
PTGC1	47.5	1.3		5.7	22.8	4.2	5.0	13.5
ROAM1	5.7	22.5	6.8	9.6	4.7	16.8	22.6	11.3
SBIO1	2.0	17.2	28.3	11.4	4.3	11.3	5.6	19.9
SGNW3	12.3	8.8	4.5	13.3	20.6	6.6	15.4	12.6
SISW1	2.6	9.5	2.5	4.7	20.8	30.2	18.0	10.7
SJNF1	3.0	7.0	11.0	11.9	14.1	22.3	24.1	4.6
SRST2	6.2	9.2	2.9	10.5	41.9	12.8	3.2	5.3
STDM4	7.1	3.9	3.8	10.2	20.4	5.1	19.4	22.1
SVLS1	1.0	6.8	12.4	12.5	21.4	23.8	10.5	7.6
TTIW1	1.3	11.4	12.2	2.4	17.1	24.0	25.5	5.8
WPOW1	19.5	43.2	3.4	6.1	25.2	1.5	0.3	0.8

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WAVE HEIGHTS (METERS)

BUOY	LAT	LONG	OBS	MAX	DY	HR	MEAN
41001	34.9N	072.9W	718	4.0	13	01	1.9
41006	29.3N	077.3W	715	2.0	13	05	1.0
42002	26.0N	093.5W	642	2.5	20	22	1.1
42003	26.0N	085.9W	686	2.0	15	21	0.7
42007	30.1N	088.9W	435	1.5	14	19	0.5
44004	38.5N	070.7W	623	4.0	06	13	1.3
44005	42.7N	068.4W	719	4.5	27	10	1.2
44008	40.5N	069.5W	719	3.5	29	02	1.2
44011	41.1N	066.6W	719	4.0	27	22	1.5
45003	45.3N	082.8W	396	2.5	01	06	0.7
45005	41.7N	082.4W	463	2.5	11	23	0.7
45006	47.3N	090.7W	261	1.0	27	20	0.4
45007	42.7N	087.1W	366	1.5	01	00	0.6
45008	44.3N	082.4W	425	2.0	01	00	0.7
46011	36.3N	120.3W	717	7.0	11	02	2.0
46022	40.5N	130.3W	718	3.5	04	18	1.0
46023	34.7N	120.7W	719	6.0	10	09	1.7
46024	50.9N	145.9W	717	5.0	12	02	1.4
46025	46.1N	131.0W	239	4.0	05	00	1.6
46006	40.8N	137.4W	457	4.0	04	01	1.8
46101	48.2N	124.7W	566	3.5	09	05	1.5
46011	34.9N	120.9W	321	2.0	06	05	1.7
46012	37.4N	122.7W	717	3.0	15	04	1.6
46013	38.2N	123.3W	687	4.0	15	04	1.9
46014	39.2N	124.0W	713	4.0	16	05	2.0
46026	37.8N	122.5W	720	5.0	21	02	2.2
46028	35.8N	121.9W	681	3.5	06	06	1.9
46029	46.1N	124.5W	717	3.5	06	03	1.6
46025	33.6N	119.0W	717	2.5	03	08	1.1
46026	37.9N	122.7W	718	3.0	05	22	1.4
46027	41.8N	124.4W	155	2.0	01	02	1.2
46028	35.6N	121.9W	719	4.0	15	19	1.9
51001	23.4N	162.3W	715	2.5	03	18	1.6
51002	17.2N	157.8W	718	3.0	01	08	1.9
51003	19.2N	160.8W	719	2.5	01	00	1.9
51 004	17.5N	152.5W	718	3.0	01	17	1.9
CHLV2	36.5N	075.7W	701	2.0	12	06	0.7
PTAC1	39.0N	123.7W	123	0.6	08	20	0.0

FREQUENCY OF WAVE HEIGHTS (%)

BUOY	CLM	1-1.5M	2-2.5M	3-3.5M	4-5.5M	6-7.5M	8-9.5M	>9.5M
41001	11.0	63.3	15.0	10.3	0.2			
41006	14.8	80.8	4.3					
42002	26.5	64.3	9.0					
42003	57.4	40.2	2.3					
42007	85.7	14.2						
44004	13.9	64.2	20.0	1.6	0.1			
44005	15.2	64.2	14.7	5.1	0.9			
44008	27.5	56.7	13.4	1.2				
44011	17.2	55.9	25.7	5.9	0.1			
45003	62.8	33.1	4.0					
45005	63.7	33.9	2.3					
45006	84.7	14.7						
45007	77.6	26.3						
45008	70.1	28.0	1.8					
46011	0.9	46.0	31.3	15.0	5.8	0.6		
46022		39.8	48.7	11.6				
46023		36.4	36.1	20.3	6.5	0.5		
46024		39.3	39.4	16.1	5.0			
46025	2.9	58.5	32.6	4.0	0.8			
46006		48.2	41.6	7.8	2.2			
46101	6.8	58.7	32.0	2.3				
46011	0.9	47.3	51.0	0.6				
46012	0.2	63.8	34.4	1.3				
46013		40.3	47.8	12.0	0.1			
46014		35.3	52.5	11.5	0.5			
46026		33.3	41.1	14.3	11.2			
46028		48.7	45.6	5.5				
46029		64.7	34.8	0.4				
46025	10.0	87.4	2.5					
46026	1.9	82.5	15.3	0.1				
46027	0.6	92.9	6.4					
46028		40.3	50.6	8.9	0.1			
51001		64.8	35.1					
51002		21.8	77.1	0.9				
51003		40.6	59.3					
51 004		26.4	73.2	0.2				
CHLV2	61.2	35.7	3.0					
PTAC1								60.1

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